

INTELLIGENCE

and its

DEVIATIONS

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THE RONALD PRESS COMPANY NEW YORK

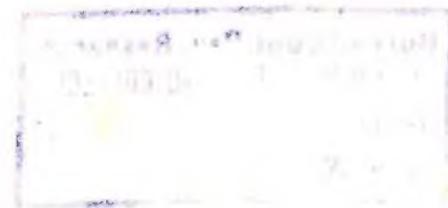


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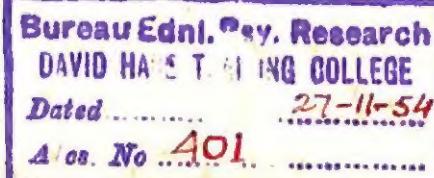
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Second Printing, January, 1947

To
MARJORIE SHERMAN

PREFACE

The purpose of this work is to present theoretical, experimental, and clinical material on intelligence and its deviations. The subject is presented in such a way that it may be used in courses in departments of psychology and medicine.

Most books on the subject have been written purely from the psychological or social standpoints, while most medical books make only passing reference to the problems of mental deficiency and retardation. This book treats together the medical, psychological, and social aspects of the subject and aims to correlate the essential data relating to each of these fields.

There are advantages to be gained through this kind of treatment. The pediatrician and the medical student should be better able to evaluate the clinical material if some of the current psychological theories are presented, even though they are not treated at great length. The pediatrician dealing with the child who is mentally retarded or shows symptoms of intellectual deterioration must also deal with the psychological factors as well as the medical, and he frequently must also consider the social problems that the child must face. The psychologist in the school who usually evaluates these problems from the intellectual and personality standpoints must, on the other hand, be aware of the medical problems and implications which determine many of the intellectual deficiencies.

The theories of the nature of intelligence and the processes of intellectual development are dealt with first. Then follows the experimental material. The last part of the book covers the physical, neurological, social, and psychological causes of intellectual retardation and deficiency. The clinical material deals with the background causes and clinical signs of the intellectual abnormalities. The bibliography, which includes the most pertinent material published to date, can be used for elaboration of any of the topics treated.

I am greatly indebted to Dr. Norman Taub for invaluable help in the compilation of the data, and to Professor Robert J. Havighurst and Dr. A. Levinson for reading the manuscript and for valuable suggestions.

MANDEL SHERMAN

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INTELLIGENCE AND ITS
DEVIATIONS

Chapter 1

A DEFINITION OF INTELLIGENCE

The Nature of Intelligence

The term "intelligence" acquired scientific meaning only after many years of ambiguous popular usage. The many conflicting interpretations of intelligence hindered the scientific work in this field for a long time. The specific use of the concept of intelligence probably developed as a result of the first tests constructed by Binet and Simon. Although a number of psychologists had previously made attempts to measure intelligence, native mental ability, performance, and achievement were for the first time systematically separated.

One of the first workers in the experimental field, William Stern, gave the following definition of intelligence: "A general capacity of an individual consciously to adjust his thinking to new requirements: it is general mental adaptability to new problems and conditions of life."¹ This definition obviously introduces further problems of definition. For example, "adaptability" is a highly complex process and cannot be accurately measured. Also, does intelligence involve only conscious adjustment or may it not function without the individual's clear awareness? A wide variety of definitions have been given by psychologists since then. Some psychologists emphasized the capacity to learn as a criterion of intelligence; others believed that ability to use abstract concepts defined intelligence; and still others defined intelligence in terms of the adequacy with which an individual solves his problems.

The diverse views on the nature of intelligence prompted the *Journal of Educational Psychology* to conduct a symposium on

¹ W. Stern, *The psychological methods of testing intelligence* (Trans. by G. M. Whipple, 1914), Baltimore, Warwick & York, Inc., p. 3.

intelligence and its measurement. One of the contributors, L. M. Terman,² stated that ability to think in terms of abstract ideas defines the degree of an individual's intelligence. He further stated that intellectual differences between two individuals cannot be defined on the sensory, perceptual, or reproductive levels but rather in terms of their relative capacity to form concepts and their ability to relate these concepts to diverse situations. Thus, according to Terman, the degree of intelligence can be measured in terms of the degree to which an individual utilizes abstract thinking in diverse situations.

Claremont³ also emphasized abstraction as the basis of intelligence, but he included in his definition the ability of the individual to understand causal relationships. He stated that intelligence cannot be defined in terms of mere learning by contiguous association, but must include the realization of causal interconnections. Carroll⁴ also stressed conceptual ability. He considered intelligence the ability to understand relationships, that is, to think coordinately and to produce a composite, unified reaction.

Many psychologists define intelligence in terms of ability to learn, that is, to profit by experience and to readjust to new situations in terms of material previously learned. Colvin⁵ considers intelligence the capacity to learn. Thus, one may measure degrees of intelligence by measuring the cumulative effect of learning. Dearborn,⁶ one of the ablest workers in this field, also defines intelligence as the capacity to learn and to profit by experience.

Although Woodrow⁷ agreed with Colvin and Dearborn, he made a slightly different emphasis. According to Woodrow, intelligence is an acquiring capacity or a capacity to acquire

² L. M. Terman, Intelligence and its measurement: A symposium, II, *Journal of Educational Psychology*, 1921, 12, 127-133.

³ C. A. Claremont, Intelligence and mental growth, 1928, New York, W. W. Norton & Co., Inc.

⁴ R. P. Carroll, What is intelligence? *School and Society*, 1928, 28, 792-793.

⁵ S. S. Colvin, Intelligence and its measurement: A symposium, IV, *Journal of Educational Psychology*, 1921, 12, 136-139.

⁶ W. F. Dearborn, Intelligence and its measurement: A symposium, XIII, *Journal of Educational Psychology*, 1921, 12, 210-212.

⁷ H. Woodrow, Intelligence and its measurement: A symposium, XI, *Journal of Educational Psychology*, 1921, 12, 207-210.

capacity. The immediate capacity of an individual thus depends upon past experience and is generally judged in terms of the degree of adequacy of adjustment. Adjustment means essentially the ability to secure desirable ends. Pintner⁸ also considered intelligence the ability to adapt to new situations. The problem of measuring adaptive behavior introduces, however, a very serious difficulty in these definitions. Norris⁹ pointed out that an individual's ability or capacity can only be inferred from observed facts. Writing from the behavioristic standpoint, Norris emphasized the difficulties that confront the psychologist when he defines capacity from inferential evidence. Some psychologists have attempted to define the nature of intelligence on the basis of innate dispositions. As expressed by Black,¹⁰ intelligence depends upon the innate dispositions or the untaught ability to appreciate the meaning of external events. Each innate disposition supposedly has two aspects. The first is the efficiency of perception and the appreciation of meaning. The second is the efficiency of reactions by which intelligence is actually judged. According to such a definition, intelligence consists of various phases because of the supposed existence of various innate dispositions. Such a concept of intelligence is clearly untenable in modern psychology, and only those who believe in the instinct theory or the theory of innate dispositions can maintain this viewpoint.

In a recent publication on the nature of intelligence, Stoddard, who has been associated with investigations of intelligence for a long time, gave a composite view of the nature of intelligence.¹¹ He defined intelligence as the ability to undertake activities that are characterized by difficulty, complexity, abstractness, economy, adaptiveness to a goal, social value and the emergence of originals, and the maintenance of these activities under conditions which demand concentration of energy and re-

⁸ R. Pintner, Intelligence and its measurement: A symposium, V, *Journal of Educational Psychology*, 1921, 12, 139-143.

⁹ O. O. Norris, A behaviorist's account of intelligence, *Journal of Philosophy*, 1928, 25, 701-714.

¹⁰ C. Black, Note on the nature of intelligence, *British Journal of Psychology*, 1928, 18, 451-454.

¹¹ G. D. Stoddard, *The meaning of intelligence*, 1943, New York, The Macmillan Co., pp. 3-42.

sponses to contradictory emotional forces. By difficulty he means the ability of an individual to solve increasingly difficult problems of any type. Thus a fourteen-year-old is expected to solve more difficult problems than a ten-year-old, and a ten-year-old more difficult problems than a five-year-old. The level of difficulty which is considered normal for any age level is therefore determined statistically. If individuals at a lower age level cannot solve that problem, then some standardization is already indicated in regard to the difficulty of the problems and a certain index of difficulty can be obtained. It is also important to evaluate the nature of a problem before it can be standardized as a measure of intelligence. The problem which is included in a test of intelligence must have practical and social significance. Thus, it is entirely logical to include a problem of arithmetic, but it would not be logical to include the ability to stand on one's hands for a given length of time. By the term complexity Stoddard refers to the breadth, or area, of intelligence. In other words, the term complexity refers to the number of tasks that can be successfully undertaken by the individual. The use of the criterion of complexity is understandable in view of the fact that most intelligence tests include a variety of tasks calibrated in an increasingly more difficult continuum. As in the case of difficulty, however, the complexity factor of intelligence must be evaluated carefully in order to include only those tasks or problems which are definitely related to the problem of general intelligence.

Abstractness has been accepted by most psychologists as one of the most important if not the most important factor in intelligence. One of the most important elements of abstractness is the ability to utilize symbolism in the solution of problems. The importance of symbolization can be easily observed in the comparison of the feeble-minded and normal child. The feeble-minded child is able to respond to practical situations in a sensori-motor way almost as adequately as the normal child, but he is unable to understand the symbolic content of his perceptions or of his actions as clearly as the average child. The greater the ability of the individual to use symbolic and abstract thinking, the higher is his intelligence. The attribute of econ-

omy, or speed, has been increasingly emphasized in current intelligence tests, especially those for older children and for adults. Speed itself is naturally not an intrinsic attribute of intelligence, but in the standardization of intelligence tests the speed of accomplishment has been found to be a practical way of comparing one individual with another. For example, a child of ten, given extended time, can solve a problem with which a normal fourteen-year-old would have difficulty. In practical situations in school, in industry, and in society in general, the time element is extremely important. For any given task, it is natural that an individual will be chosen who can perform it in less time than another.

By including the attribute of adaptiveness to goal and social value in his definition of intelligence, Stoddard implies that mental activities which are undirected have no functional or constructive value, hence cannot be included in a diagnostic statement of an individual's intelligence. Thus, aimless or rigid behavior, however adequate it may be at the moment, cannot be considered intelligent behavior. In naming the attribute of "emergence of originals," Stoddard implies that at the higher levels originality can be used as an important index in defining the individual's intelligence. Unfortunately, it is difficult to test an individual's originality, and only observation over a long period of time can allow the observer to understand the degree of originality which an individual shows.

The biological aspect of intelligence was emphasized by Peterson.¹² He considered intelligence a biological process, the mechanism of which results in the bringing together of the effects of stimuli so that they are unified in adaptive behavior. The degree of intelligence, according to Peterson, increases with the range of receptivity to differential stimuli and with the degree of organization of the responses. Thus, the emotionality of the individual, his responsiveness to abstract symbols, the degree of energy, and so on, are phases of intelligence. General intelligence, according to this viewpoint, is probably not a separate or constant factor but a composite of many different

* ¹² J. Peterson, Intelligence and its measurement: A symposium, IX, *Journal of Educational Psychology*, 1921, 12, 198-201.

abilities. Other investigators have also been concerned with the nature of the composition of intelligence.

Intelligence obviously is not a single mental process but a practical concept connoting a group of complex mental processes.¹³ These processes, grouped in a pattern and called intelligence, are natively characteristic in various combinations in every individual and may be compared quantitatively in terms of efficiency, capacity, and rate of learning. Hence, learning ability involves the expression of a complex pattern of a large number of mental processes. Many conditions may cause a change of such a pattern, and as a result the measurement of learning ability may not always be an adequate method of estimating an individual's intelligence.

Abilities and Factors

The evaluation of the basis of intelligence involves the problems of whether intellectual capacity is the manifestation of a single ability or of multiple abilities. Thorndike¹⁴ was one of the first psychologists to attempt a systematic definition of the components of intelligence. He considered general intelligence divisible into a number of components. Practically, they manifest themselves in a capacity to adjust to abstractions, to social relationships, and to mechanical or objective problems. Each component is related to the specific data or tasks with which the individual is dealing. Hence, there may be as many components as there are tasks. The correlation between the abilities in various tasks is less than 1.00, because of differences of emphasis in training. The development of intelligence involves an increasing adequacy of selection, analysis, abstraction, generalization, and reasoning.¹⁵

The most serious controversy among psychologists dealing with intelligence relates to the problem of whether there is a

¹³ See M. E. Haggerty, Intelligence and its measurement: A symposium, XIII, *Journal of Educational Psychology*, 1921, 12, 212-216.

¹⁴ E. L. Thorndike, Intelligence and its measurement: A symposium, I, *Journal of Educational Psychology*, 1921, 12, 124-127.

¹⁵ E. L. Thorndike, E. O. Bregman, M. V. Cobb, and E. Woodyard, The measurement of intelligence, 1927, New York, Teachers College, Columbia University, pp. 412-432.

single general ability or a definite number of specific intellectual abilities. Spearman¹⁶ is generally regarded as the most important worker in this field. He was the first to postulate a general factor and specific factors of intelligence, symbolized as g and s . He observed that the coefficients of correlation between various measures of mental ability were usually high, in many cases very close to 1.00. He concluded that there must be some common fundamental function responsible for the high correlation between apparently dissimilar intellectual activities. This common central function, g , is the individual's general ability which remains stable and constant from test to test. It is also involved in all developmental processes but is not in itself a special process. Spearman stated that unless we assume a common fundamental function or perhaps a group of functions, we cannot explain the high correlations which appear between phases of intellectual activity which are quite dissimilar. The specific elements of intelligence, the s 's, are distinctly different from each other and vary from test to test. Each s depends upon the sensori-motor peripheral apparatus, upon retentivity and fatigability. The amount of g of an individual is to a large degree determined by heredity and is thus only slightly influenced by education and training. The s factors are, on the contrary, quite distinctly influenced by training and environment. Age influences g but has only an indirect effect upon the s 's. The factor g increases rapidly at first and matures at about fifteen or sixteen years of age, following which growth of this factor definitely ceases. This growth curve cannot be shown for s , however. The growth curves of s depend upon the sensitivity of the peripheral sensori-motor organization and upon retentivity and fatigability.¹⁷

The Spearman theory of two factors derives its support from evidence obtained from the statistical technique of tetrad differences. When the results of different tests are correlated, the coefficient is less than 1.00 because of chance error and the effects of different s 's. By the tetrad equation, however, the

¹⁶ C. Spearman, "General intelligence" objectively determined and measured, *American Journal of Psychology*, 1904, 15, 201-292.

¹⁷ C. Spearman, *The abilities of man*, 1927, New York, The Macmillan Co.

effects of s are canceled out, and the differences are a theoretical 0. In practice, however, the tetrads only approximate 0 but do not vanish entirely. In a number of recent studies the investigators were unable to show a distribution of tetrads which would be expected if only two factors were operative. Opponents of Spearman's theory have shown theoretically that the vanishing of the tetrads probably constitutes no absolute proof of the parallel existence of g and s . Furthermore, on the theory of multiple factor technique one might expect true tetrads to average 0.

Tryon¹⁸ especially emphasized, by citing ten studies, that the expected distribution of observed tetrads did not occur if only two factors were operative. In answer to such criticisms the proponents of the two-factor theory postulated group factors as "disturbers" of tetrad equations which account for the failure of these equations to average 0. Certain abilities are regarded as group or special factors, such as logical, mechanical, and arithmetical abilities, whereas perseveration and inertia appear as unitary mental factors.

Instead of a general factor, Thomson¹⁹ proposed a sampling theory or a theory of a number of factors to explain the observed correlations. In any given activity such as is involved in a mental test situation, an individual uses a random sample of all the group abilities he has. Thus, a large variety of samples will actually have factors common to all the activities. This theory does not deny general ability but does deny that the general factor is necessarily of the same nature in different persons. Also, the general factor of one person is not necessarily psychologically of the same nature as the general abilities of another person. Tryon,²⁰ claiming that there is no good reason to postulate a single g factor, agrees with some workers in theorizing a number of more or less independent factors which overlap and determine intercorrelations between various abilities.

¹⁸ R. C. Tryon, Multiple factor vs. two factors as determiners of abilities, *Psychological Review*, 1932, 39, 324-351.

¹⁹ G. H. Thomson, General versus group factors in mental activities, *Psychological Review*, 1920, 27, 173-190; G. H. Thomson, A hierarchy without a general factor, *British Journal of Psychology*, 1916, 8, 271-281.

²⁰ R. C. Tryon, So-called group factors as determiners of abilities, *Psychological Review*, 1932, 39, 403-439.

The recent controversial discussions in the field of intelligence testing resulted in part from the various interpretations of differing statistical techniques. In a series of investigations of children of various age levels, Kelley²¹ failed to find sufficient evidence to justify the theorizing of a single general intellectual factor. Kelley's results indicated that correlations reported by various investigators which seemed to support Spearman's theory were probably due in part to such factors as maturation, race, sex, and training differences. Kelley believed that there may be two or three traits combined in Spearman's *g* factor. According to Kelley, his results suggest that a verbal factor may be the core which closely approximates Spearman's *g*.

On the basis of his studies Kelley²² proposed many other factors such as:

1. A general factor due to heterogeneity in maturity, race, sex, and general nurture.
2. Facility with verbal material.
3. Facility with quantitative concepts.
4. Facility in the mental manipulation of spatial relationships.
5. Speed of mental processes.
6. Memory facility, that is, a general factor operating with reference to words, numbers, and spatial material.
7. A drive of interest.

In support of the thesis that other factors may be present and may be specialized and differentiated, Schneck²³ experimented with 210 college men, eighteen to twenty-one years old. When he used the tetrad difference method, he found that the verbal tests contained a central factor present in each test and factors specific for each separate test. In the same way a common factor was found in all the number tests as well as the specific factor in each of these tests. The verbal and numerical abilities were found to have little in common with each other,

²¹ T. L. Kelley, *Crossroads in the mind of man*, 1928, Stanford University, Stanford University Press.

²² T. L. Kelley, *Essential traits of mental life*, 1935, Cambridge, Harvard University Press.

²³ M. M. R. Schneck, *The measurement of verbal and numerical abilities*, Archives of Psychology, 1929, 107, 49.

however, and the inference was that each test must have had some factor which was not present in the others.

Schiller²⁴ gave twelve tests to nearly four hundred children. These tests were composed of vocabulary, analogies, sentence completion, reading, number series, arithmetical reasoning, computation, and five spatial tests. The data were treated by Spearman's tetrad analysis. Schiller found a common factor in the verbal, number, and spatial groups and also a common factor throughout any two categories. One of the inferences was that specialization of mental abilities is the result of maturity of intelligence and is influenced by environmental conditions. In other words, differentiation is one of the accompaniments of mental growth.

Thurstone and his co-workers also applied the theory of factorial analysis to the study of mental abilities. In general, the results did not substantiate the presence of the general factor of which Spearman speaks, although there was some indication that a common factor may be present. Thurstone postulated nine primary factors as a result of his studies with a battery of 56 tests.²⁵ They were tentatively named spatial, perceptual, numerical, verbal relations, verbal fluency, memory, induction, restrictive reasoning, and inductive reasoning. The last two factors are tentative.

Freeman is one of the strongest critics of the theory of factors or abilities as it is usually derived from the statistical treatment of the results of various types of tests. He believes that the data do not warrant the specific theories which have been advanced. He believes that these theories resemble the old faculty theory which was rejected long ago. He states, for example:

It is hard to see that it makes any difference whether memory, language, mathematical facility, spatial imagination, etc., are called faculties or primary abilities. Certainly the phrenological conception that faculties depend on the structure and

²⁴ B. Schiller, The factor pattern yield of twelve tests of intelligence, *Journal of General Psychology*, 1937, 16, 311-321.

²⁵ L. L. Thurstone, Unitary abilities, *Journal of General Psychology*, 1934, 11, 126-132; L. L. Thurstone, Primary mental abilities, *Psychometric Monograph*, 1938, No. 1.

development of localized areas of the brain is not admissible. It is hard to conceive a form of brain structure that would explain native individual differences in abilities like the ones named. They could more easily be explained as organized habits or modes of behavior.²⁶

Freeman also believes that a concept of brain organization and action might fit better the notion of intelligence as represented in a variety of intellectual operations than Spearman's concept of a general factor consisting of only two processes. This, Freeman believes, is especially pertinent in view of the fact that intellectual ability is exhibited better in the complex than in the simple operations and in abstraction and generalization rather than in manipulation of the particular and concrete. Spearman²⁷ also criticized the theory of primary abilities in somewhat the same way as Freeman, but much more directly. Spearman believed that the theory of primary abilities is merely a reconstitution of the old faculty theory in a new guise. He criticized especially the attempt to describe various abilities as if they were separated by a definite number of more or less watertight compartments. He believed that the results of some investigators appear only from "statistical accident," and that factors are not primary but represent those parts of tests which overlap with parts of other tests. By reworking Thurstone's data, for example, Spearman found only the group factors, verbal, spatial, numerical, memory, and speed.

Factor Analysis

The current literature contains a large number of reports of factorial studies. In none of them is there conclusive evidence of a universal or general factor in the sense of Spearman's *g*. Nevertheless, the factors found by the newer statistical analyses cannot at present be considered as circumscribed underlying factors. Tryon²⁸ stated that the methods employed reveal

²⁶ F. N. Freeman, *Mental tests*, 1939 (rev.), Boston, Houghton Mifflin Co., p. 441.

²⁷ C. Spearman, *Thurstone's work re-worked*, *Journal of Educational Psychology*, 1939, 30, 1-16.

²⁸ R. C. Tryon, *Cluster analysis: Correlation profile and orthometric (factor) analysis for the isolation of unities in mind and personality*, 1939, Ann Arbor, Edwards Bros., Inc.

"pheno-typic operational unities." In other words, they are not necessarily causal, primary, univocal, indivisible determiners of differences, as is naturally implied in the factorial analysis technique.

In evaluating the various statements and techniques of the workers in this field the conclusion may be reached that general intelligence is a composite of elements which appear differently in different tasks or tests. The results of some investigators have not been corroborated by the results of other investigators. Alexander,²⁹ using nine tests, found that but one factor was positively correlated with every test in the battery and thus there apparently was a common factor. A number of abilities formed close communal clusters, and a number of measures functioned almost alike and thus may be called functional unities.

The types of tests used and the techniques employed determine to some degree the kinds and frequency of factors found. It may be possible to use techniques which show twelve primary factors or even thirty. The fact that these primary factors cannot be explained in terms of definite hereditary laws does not allow either for their negation as primary factors or for their proof because there is no way to prove or disprove their existence except by the specific techniques employed by a given technician. Not only is it difficult to trace common hereditary factors in a normal individual, but there is also a great deal of difficulty in describing hereditary factors in defective children. In part this is due to the lack of specific genetic studies of mental defectives. In part this is also due to the fact that the measure of mental ability is a measure of a complex pattern of abilities which manifests itself in a task which is quantitatively evaluated. It appears, therefore, that intelligence should be considered as a complex pattern of a large number of specifically manifested abilities which develop with growth and become differentiated only with learning and experience. The particular names applied to these abilities are immaterial, because the names which are employed to describe abilities are chosen as

²⁹ W. P. Alexander, Intelligence, concrete and abstract, *British Journal of Psychology Monograph Supplements*, 1935, 6, No. 19.

the result of common usage. As Tryon implies, a specific statistical technique may merely define an ability in terms of that technique and may not define it as something inherent and perhaps hereditary. The fact that all the abilities develop at an approximately similar rate in normal individuals may indicate the arbitrariness of specifying them as separate inherent factors. The fact that they may be differentiated at a higher or lower level in some individuals does not deny the assumption that the different elements of the original complex pattern begin at the same level. The differentiation, as many workers have pointed out, is due to specific learnings and experiences, and when one ability (performance on a given task) is higher or lower than another ability, the difference may be due to specialization.

Qualitative Aspects of Intelligence

What constitutes the core of intellectual activity? Performance on a given task is only the overt manifestation of a more basic process. Most psychologists agree that an accurate measure of a person's intelligence is possible only when his capacity to form and express concepts (abstract thinking) can be estimated. Conceptual mental activity involves recognition of the *meaning* of specific objects or various elements in a situation as they symbolize other objects or situations. This leads to generalizations, and therefore makes adjustments possible to new conditions without the necessity of a trial and error process, although it is probable that such a process always takes place to some degree. The elements of the conceptual process include those phases of intelligence which can be measured with some accuracy by the psychologist, such as memory, judgment, and reasoning.

Conceptual mental activity thus represents the final phase of the development of intelligence, beginning in its earliest manifestations with simple sensori-motor reactions. The first signs of conceptual mental activity, at least in its outward manifestations, appear in the development of speech and language. Through linguistic activity, concept formation can be observed and its development followed with fair precision. The construction of the mental growth curve on the basis of intelli-

gence tests, which will be discussed in the next chapter, has shown, however, that the correlation between the early sensori-motor responses of the infant and the later manifestations of intelligence on tests involving verbal and symbolic reactions is not very high. This might at first appear as if the two processes, sensori-motor adequacy and conceptual mental activity, are unrelated. Most psychologists maintain, however, that there is a direct relationship between these two types of intellectual processes. The low correlation is generally ascribed to the fact that the tests at the infant level are not of the same order or nature as the tests at later levels. It can be logically assumed that the early reactions that function as intellectual adaptations, many of which attain complete adequacy at an early age, are the origins of the later intellectual processes. In other words, conceptual mental activity is of the same order as the early sensori-motor responses, manifested, however, in symbolic fashion. It has been shown that those infants who are retarded in developing sensori-motor adequacy are also retarded in their speech, in their language development, and in their concept formation. A child who does not walk until he is sixteen months of age will usually be less intelligent than a child who walks when he is twelve months of age. In general, walking precedes talking, and talking precedes those intellectual reactions which can be designated as concept behavior. There is a great deal of overlapping, however, and the stages are not specifically delimited. Terman³⁰ found that talking sometimes precedes the ability to walk in very intelligent children.

Symbolism and Intelligence

According to Munn,³¹ concepts are symbolic in that they depend upon generalizations from absent objects and situations. A concept evolves from a stimulating situation which is compared with and related to past situations. The evaluation of the stimulus is not necessarily conscious, nor is the process verbal-

³⁰ L. M. Terman, Editor, *The early mental traits of three hundred geniuses*, *Genetic Studies of Genius*, II, 1926, Stanford University, Stanford University Press.

³¹ N. L. Munn, *Psychological development*, 1938, Boston, Houghton Mifflin Co., pp. 348-354.

ized. Munn also infers that certain animals behave conceptually because they are able to learn a generalization. Most psychologists, however, deny that there is symbolic learning or behavior in animals. They may be able to relate one object to another or to respond to elements in a new situation which they have experienced in past situations. From this standpoint some psychologists believe that the process of concept formation is determined by the selection of elements from past experience and the use of these elements in new situations.

Symbolic processes are generally described in terms of expressive movements, linguistic reactions, imaginative and ideational processes, concept formation, abstraction, and reasoning. The overt expressions, such as substitute linguistic reactions and habitual gestures, are the result of internal formulations which develop into symbol patterns and are highly useful because of their economy of time and effort. The expressive movements of animals are, however, not interpreted as symbolic. They are in reality postural habits which aid in adjustment to an immediate situation. In man, the essential core of symbolism is the substitution of representative processes in the absence of the original stimulus, and results in selective responses. The residual of the original stimulus acts as a surrogate for it. The essential difference between animals and man is illustrated in experiments such as Hunter's on the delayed reaction. Hunter found that the dog and raccoon, though differing in the amount of delay in their responses to a stimulus, were unable to respond as adequately as a child. The dog, for example, when he did respond after a slight delay, was found to do so as the result of "pointing," which is essentially a postural habit and not a delayed response involving symbolic behavior.

According to Markey,³² a symbol may be defined as an act or object which is substituted for a stimulus object or other act. This does not mean that symbolic behavior is merely a complex conditioned reaction. Thus, it is important to differentiate between the symbols to which man reacts symbolically

³² J. F. Markey, *The symbolic process and its integration in children*, 1928, New York, Harcourt, Brace & Co.

and the signs to which he reacts. A sign defines a condition or a person and sometimes also an abstract principle. The badge of a conductor is a sign, designed to specify and differentiate the wearer so that his functions may be recognized quickly. It is not, however, a symbol. According to Ogden and Richards,³³ language plays the most important role in the development of symbolism and in symbolic behavior. Symbols direct, organize, record, and communicate ideas and thus make abstractions and generalizations possible. The communication of symbols may take place in a variety of ways, such as through words, gestures, drawings, or mimetic signs.

Other definitions of symbolism have been given, but they are not significantly different from those already described. Healy, Bronner, and Bowers³⁴ attempted to evaluate symbolism from the standpoint of its meaning for the psychoanalytic theory. According to these authors, symbolization is an unconscious process built upon association and similarity whereby one object becomes representative of another object. The importance of symbolization to the psychiatrist is due to the process of displacement of emotional values from one object to another, a process which frequently results in behavioral distortions.

Psychologists generally believe that the level of symbolization, that is, the complexity of symbol and response, defines the ontogenetic level. In the process of development there is a definite pattern of growth from concrete gestural communication through the holophrastic to the highest forms of linguistic abstractions. This process has in part been recognized and described as the result of studies of child development and in part by comparison of defective and normal persons. Psychologists have defined the defective person as an individual whose symbolic processes are not fully developed. The more highly developed person tends to be more abstract and less concrete. He tends to differentiate unrelated objects, problems, and principles, and also to relate analogous situations accurately. As

³³ C. K. Ogden and I. A. Richards, *The meaning of meaning*, 1930 (rev.), New York, Harcourt, Brace & Co.

³⁴ W. Healy, A. F. Bronner, and A. M. Bowers, *The structure and meaning of psychoanalysis as related to personality and behavior*, 1930, New York, Alfred A. Knopf, p. 206.

we shall see later, many of the tests of intelligence involve measurement of the ability of an individual to relate analogous objects or conditions and to differentiate linguistically unrelated objects or conditions.

The development of symbolization in the process of intellectual and, concomitantly, cultural development, has been emphasized by many anthropologists. Some anthropologists believe that they have traced the growth of symbolization from concrete and gestural communication among primitive people to the complex linguistic responses of the peoples of higher levels. Spoken language through which symbolization can best be communicated supposedly had its origin in gestural language which had a strong emotional component. As cultural evolution progressed, these gestures become inadequate for the new relationships which were being established among individuals. Even in the "primitive" cultural periods many complex symbols were employed. The ideas of magic, of spirits, and of other conditions may have been as complex as the types of symbols which are employed in our society. According to some investigators, the evolution of representation into symbolism which has been described by anthropologists supposedly occurred concurrently with the evolution of the nervous system.³⁵ According to this theory, the nervous system maturation of the infant may determine the development of his symbolic reactions.

It is difficult to define the exact level of symbolic development. It is known that as the symbolic development of the child progresses he is more and more able to adjust on the basis of memory and anticipation. He is able to recognize cause and effect more definitely as his symbolisms gradually widen. At first they are centered around himself but gradually include more and more social experiences. Concepts which have very little relationship to the immediate situation become more definitely a part of the child, and he is able to anticipate and project.

Conclusions regarding the growth of symbolism have generally been made from inferential data and not from empirical studies, but some investigations have furnished important data.

³⁵ J. Rosett, *The mechanism of thought, imagery, and hallucination*, 1939, New York. Columbia University Press.

For example, studies of delayed reactions of children have shown that the length of the interval after which a correct response can be made is 5 minutes at one year, 20 minutes at two years, and 30 minutes at three years. This increase in the period between the stimulus and the correct response indicates the growth of symbolic response. The types of clues which children use in remembering are also an index of their level of symbolization. For example, feeble-minded children may be able to repeat six or seven digits forward but are unable to repeat three or four digits backward. The motor "set" which is an aid in enabling a child to repeat a series of digits may be of little value in repeating the series backward. Tests involving uncompleted sentences have also been used as measures of concept development and therefore of symbolic behavior. The completion of an uncompleted sentence involves imaginative thinking and the use of symbols in completing an idea.

A report of an ingenious study of the development of concepts was made by Hicks and Stewart.³⁶ They investigated the ability of children to select a middle-sized cube from three different cubes. The ability of the children to select the cube which was of middle size was an indication of the adequacy of their concepts—an expression of the level of their symbolic responses. Six boxes (cubes open on one side) were used, the largest being 14 centimeters long and the smallest, 4. The boxes were covered with red paper and were identical except for size. A toy was placed under the middle-sized box in order to motivate its selection and to enable the child to recognize a correct response. The six boxes were arranged in four series of three boxes each, so that a box identified as middle-sized in one series assumed a different relationship in the next. The positions of the boxes were also constantly changed. Thus, it was necessary for the child to make a generalization from one series to the next regarding size relationships. The results showed that two-year-olds failed in the first series, but the three-, four-, and five-year-olds learned the four series. The number of errors, the means, medians, and the range of time consistently decreased

³⁶ J. A. Hicks and F. D. Stewart, *The learning of abstract concepts of size*, *Child Development*, 1930, 1, 195-203.

with age increase. Within every age group there were large individual differences, however.

TABLE 1

NUMBER OF PRACTICE PERIODS AND NUMBER OF ERRORS FOR AGE GROUPS
ON THE SIZE RELATIONSHIP TEST
(Hicks and Stewart)

	Three-Year-Olds		Four-Year-Olds		Five-Year-Olds	
	Practice Periods	Errors	Practice Periods	Errors	Practice Periods	Errors
Total.....	77.0	158.0	60.0	52.0	50.0	19.0
Mean.....	7.7	15.8	6.0	5.2	5.0	1.9
Median.....	7.0	10.0	6.0	4.0	5.0	1.0
Range.....	6-12	2-54	4-8	0-16	4-7	0-11

It is frequently impossible to define the exact intellectual level of a mentally defective child because of the difficulty of differentiating the relative importance of conceptual development and linguistic symbolic ability. As an example of this difficulty, studies of schizophrenic children have shown that they frequently fail on some items of mental tests because they cannot respond with the proper symbols. Examination on performance tests shows that many of these children are intellectually normal and manifest no signs of mental deterioration. The defective child is usually deficient, however, in the capacity to adjust to objective situations as well as in symbolic behavior. A defective child can be trained to respond habitually to a specific situation. When the situation is changed he may fail if there is a significant difference between the old situation and the new. When the language development of the defective child is examined, it is easy to understand the difficulty he has in adjusting by concepts. He may be able to verbalize specific needs and to respond outwardly in a direct manner. He is unable, however, to generalize, to abstract properties from one situation and to apply them to another, and to respond to absent or anticipatory conditions. If it were possible to construct a test which accurately measured the level of concept develop-

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ment, the exact intellectual level of a child could be more accurately measured than by the ordinary "performance" tests which are now available.

Speed and Power

The relative importance of speed or power as a criterion of intelligence has been extensively studied by psychologists. Many psychologists believe that speed is not only important as an index of intelligence but is also probably the most important measure. Others believe that although speed may be used as an index of intelligence, because it can be easily measured, it is not necessarily a basic index. Thus, each test which utilizes speed must be evaluated individually in order to ascertain the relative importance of power and speed.³⁷

Many tests which have been devised for children are principally power tests, but a great deal of attention has been given recently to the inclusion of the element of speed as one of the important measures. The assumption that power rather than speed is the most important index of intelligence is based on the further assumption that innate intelligence develops in an orderly and sequential process and that, in general, ordinary variations of environment have little influence upon performance. Intelligence tests for adults include the factor of speed, perhaps as their most important element. It is assumed by some psychologists that this is due to the nature of adult performance, that is, innate capacity has matured and tests therefore measure, to a large extent, acquired capacity. Furthermore, the criteria of intellectual levels in terms of adequacy of adjustment are somewhat different for adults than for children. Speed becomes an important element in adult behavior although it is not unimportant in children. The problem of evaluating the factor of speed may be illustrated in the following way: Suppose two adults are given a test of intelligence. Both attain a score of 160. One person performed on 180 items and the other

³⁷ See F. S. Freeman, The factors of speed and power in tests of intelligence, *Journal of Experimental Psychology*, 1931, 14, 83-90; and L. F. Beck, Relation of speed of reaction to intelligence, *American Journal of Psychology*, 1932, 44, 793-795.

on 162. Let us assume that one has therefore made only two errors and that the other has made twenty. The question is, Which of these two persons is the more intelligent? Does the person who has greater speed of performance show more intelligence in spite of the greater number of errors or is the person who makes only two errors more intelligent? This problem can be illustrated in other ways. Consider, for example, the person who makes a score of 160 but who has made no errors. Compare him with a person who makes a score of 170 but makes, say, thirty errors. Is the person who is meticulous, whose mental processes are deliberate and accurate, more intelligent than the person who makes a higher score but who is likely to make many errors? Naturally, questions will arise regarding the distractability of the person who makes the higher score, his ability to concentrate, and the possibility of emotional interference. Let us assume, however, that both persons are as nearly alike as possible regarding the factors of attention, concentration, and emotionality. Most psychologists will agree that the person who makes the higher score is the more intelligent in spite of the greater number of errors. Speed, therefore, is considered an integral factor of intelligence, although the actual score is naturally a measure of "power."

Many other problems have arisen relating to the evaluation of the qualitative nature of intelligence. It is generally assumed that intelligence manifests itself in a complex but fully integrated manner. The fact that Spearman has shown a general factor and many specific factors and that Thurstone has classified a given number of primary abilities does not deny the assumption that intelligence is a constellation of discrete abilities which, however, cannot be dissociated except as the different items of a given test make for such dissociation. This is shown by the failure of psychologists to produce significant evidence to support the frequent assumption that most persons show special abilities. Indeed, some psychologists believe that each person has some special ability or abilities which are beyond the level of his general ability. The evidence so far reported shows, however, that when special abilities have been recognized they generally result from special training and special experiences.

The division of intelligence into various aspects, such as Thorndike attempted, has never been verified by experimental investigations. There has never been any evidence to show that intelligence can be definitely divided into social, concrete, and abstract forms. Some investigators have assumed that a child or an adult may have a higher mechanical ability than abstract mental ability irrespective of special training. This concept has been used in many schools by assigning to vocational training those children who show little aptitude for ordinary school subjects. Many careful studies have shown, however, that a high correlation exists between the kind of performance which is ordinarily called mechanical and the scores on the usual mental tests. Educators have sometimes been misled by the improvement of retarded children in activities which are mechanical in nature. This is generally due to the fact that defective children can learn simple sensori-motor activities as quickly and as efficiently as bright children. As has been stated previously, the curve of sensori-motor adequacy matures at an early age, and it is natural to expect that with proper training retarded children will be as adequate as normal children in performances which require gross sensori-motor adjustments. Beyond the point of simple sensori-motor ability the defective child lags behind the normal child in mechanical ability and ingenuity. Special performances which are not due to special training correlate highly with the kind of performance that is generally the result of conceptual and abstract mental processes.

Many of the controversies regarding the nature of intelligence have arisen because the overt manifestations, that is, the adjustment of the individual, are frequently not commensurate with the results of tests. A child with an I.Q. of 120 may be less effective in his adjustment than a child with an I.Q. of 90. Many factors enter into the determination of the intellectual adjustment of a person. For example, the drive of the individual, that is, his energy and determination, are important influences in maintaining a given level of intellectual efficiency. The perseverance of a person is also important. There are also various kinds of judgments which determine intellectual efficiency, but which cannot be adequately measured by the usual

tests. The effectiveness of intelligence is shown in the ability to adjust adequately to novel and critical situations. The adequacy of such adjustments depends upon a delicate integration of general and specific abilities reinforced by emotional stability, perseverant drives, and an ability to withstand frustration and failure.

Some persons' intellectual adjustment is characteristically below their true capacities, whereas others work at the very top of their capacities. This is not always due to differences in motivation but often to differences in the way the intellectual abilities are integrated and functionally effective. This variability of functional effectiveness presents an important research problem to psychologists and psychiatrists. The problem has led some students to theorize on difference in the qualitative aspects of intelligence. One of the common impressions is that two persons may have the same I.Q. but may differ greatly in the qualitative aspects of their intelligence and thus differ in their performance. It is obvious that a great deal of research must be carried on in order to discover the different forms into which intellectual abilities are patterned.

Chapter 2

MENTAL GROWTH

The Construction of the Growth Curve

Mental growth is defined as the progressive increment in mental ability with increase in chronological age. The use of chronological age as a criterion of the measurement of intellectual growth is convenient and represents those vaguely defined forces which are responsible for growth, the effects of which are manifested with the time increment.

No one has defined the precise factors which are responsible for mental growth, but presumably they are the common factors which are also responsible for anatomical maturation, physiological development, and functional coordination. Generally, these concomitant growth factors are not utilized in the construction of a mental growth curve except in specific studies involving a given factor. Ordinarily, chronological age represents one axis, each month or year unit representing the standard. These units thus represent all maturational changes and also presumably represent as a unit the complex results of all the growth increments.

Most of the studies of intellectual growth have been made by the cross-sectional method. This method means simply that a fair sampling is made of children of various age levels, and the averages at various levels represent the points on the growth curve. There has been a great deal of controversy in recent years regarding the merits of longitudinal studies. Some investigators insist that we are unable to understand any development unless a representative group of children is examined from year to year. They believe that the variability from test to test and from individual to individual is so great that the cross-sectional method may introduce many artifacts. The proponents

of the longitudinal method have overlooked a simple statistical fact. A given child's development can be plotted only by studying him at successive age levels. But the study of a fair sampling of the population at successive ages is merely another way of making a longitudinal study.

The greatest difficulty which has been encountered in the construction of a growth curve results from the lack of adequate tests which measure the same abilities at different ages. Psychologists have been unable to construct tests which measure similar capacities at various ages so that the results may be evaluated on the basis of quantitative differences without the disturbing factor of qualitative variations. As an example, the Stanford revision of the Binet test is used from ages two to fifteen. The measurement of the progress of the ten-year-old requires test items which may appear to be like those required of the five-year-old. They are actually not similar, however.

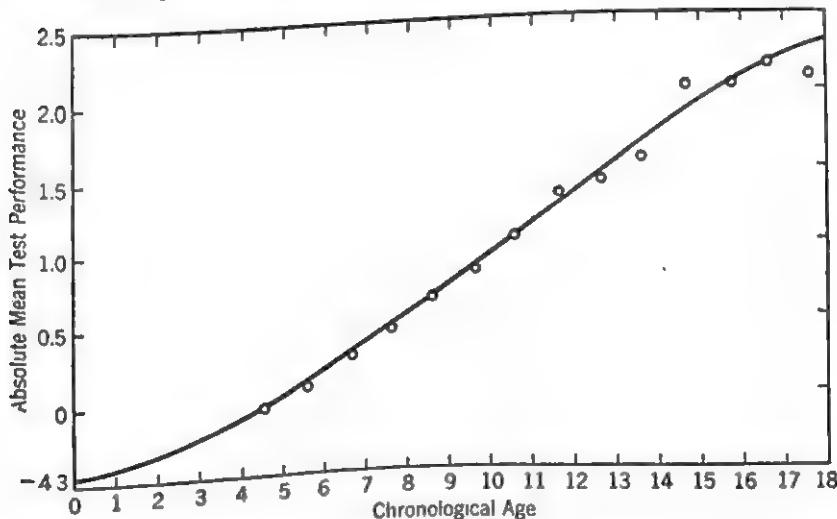


Figure 1. Mental Growth Curve for the Binet Tests

The population on which the data for this curve were obtained is retarded with a mean I.Q. of about .8. The curve is based on an absolute unit of measurement (absolute scaling) starting from three years of age. The absolute zero (defined as the mean test performance at which the variability vanishes) was found to be -4.3σ for these data. Note that the growth curve is positively accelerated in the younger ages and is asymptotic to the absolute zero. (From L. L. Thurstone and L. Ackerson, The mental growth curve for the Binet tests, *Journal of Educational Psychology*, 1929, 20, 576)

The difficulty arises when comparisons are made at the two extremes of the curve. The responses of the infant one year old cannot be compared with the reactions of a fifteen-year-old, unless we are willing to assume that a sensori-motor reaction is not only a precise index of mental growth but is also a measure of the same type of ability which is manifested by the verbal ability, arithmetical ability, or abstract mental activity of older children. As we shall see later in the discussion of the methods of testing, many of the contradictions between the results of various investigators are due primarily to the difficulties inherent in comparing the responses of children of various ages on the same test scales or on different tests. Another difficulty arises from the fact that raw score units are seldom equal for the entire scale of a complex test. It is more difficult to succeed from one test item to the next at given age levels than at others. One way of overcoming these difficulties was employed by Thurstone,¹ who developed a method of absolute scaling in which raw score units are arranged in such a way that they may be converted to make the units of mental measurement equal throughout the entire scale. It is obvious that a mental growth curve can be more accurately constructed from absolute scoring units, which are constant, than from variable items.

A large number of other problems arise in the construction of a mental growth curve. At what point does mental growth begin? Does a mental growth curve represent a single ability or an average of many components? Does the mental growth curve definitely stop at from fourteen to sixteen years of age as many investigators have contended, or does it continue to grow, as F. N. Freeman and others have recently pointed out, after the age at which maturity is usually supposed to have been reached?

Origin of Mental Growth

It is obviously impossible to define the exact zero point of intelligence. Intelligence cannot be measured with any degree of accuracy in fetal life or even within the first six or twelve

¹ L. L. Thurstone, The absolute zero in intelligence measurement, *Psychological Review*, 1928, 35, 175-197.

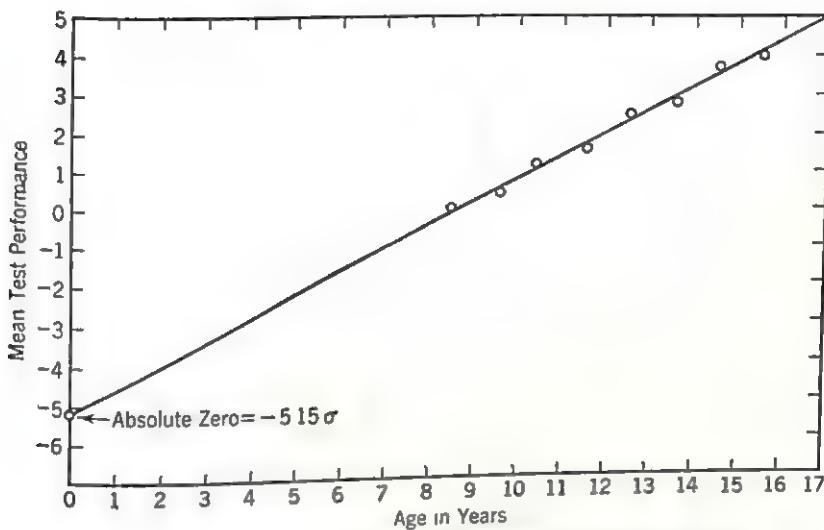


Figure 2. Mental Growth Curve (National Intelligence Test)
(From Thurstone, p. 193)

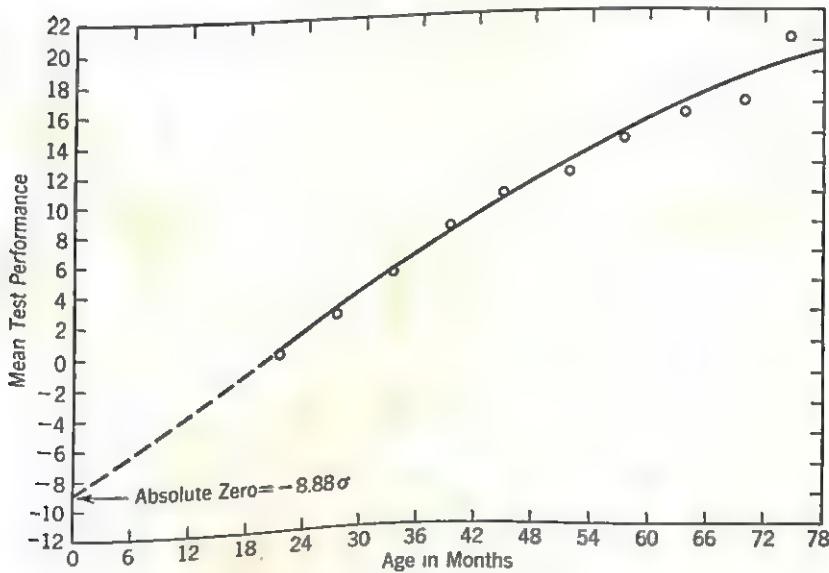


Figure 3. Absolute Mental Growth Curve (Stutsman Test)
Linear growth of curves determined from means from the data and projected downwards until they reach zero age. The value of that point agrees with the absolute zero as determined by the variability curve of the same data. This shows that intelligence, as measured later, begins at about birth. (From Thurstone, p. 194)

months of neonatal life. Recent studies have shown that a variety of sensori-motor reactions occur even in early fetal life, but the question naturally arises whether these adjustmental reactions are similar in nature to those which occur in a newborn infant and whether either or both represent the kind of intelligence which we ordinarily measure in the older child. The ordinary mental growth curve represents a zero, that is, a beginning, and implies a zero score on whatever test is used. This naturally does not mean "zero" intelligence. In Thurstone's method an attempt was made to overcome this difficulty by extrapolating the growth curves based on various tests during definite measurable ages. As a result of this method, the absolute zero is said to occur shortly before or at birth. Other investigators using this technique of extrapolation have found that one might assume that intelligence begins late in fetal life. Thus, the curves of Richardson and Stokes² indicate that at the time of birth there has been approximately 6½ per cent development. According to this method, the speculation is made that intellectual development reaches 96 per cent by the time the individual is eighteen years old and 99 per cent at twenty-four years. In actual practice, however, the mental growth curve graphically illustrates only the development of native intelligence from birth to maturity, that is, from birth to the age of fifteen or sixteen. Thus, the growth of intelligence is assumed to *begin* at birth.

Statements regarding the degree of development of intelligence at birth and at various age levels up to maturity must be considered highly speculative. There is still a great deal of controversy, for example, regarding mental maturity. Some investigators believe that innate ability matures at the age of sixteen; others believe that it matures at fourteen or fifteen. Conclusions regarding intellectual maturity at any of these ages depend in part upon the kinds of tests employed. Most tests are influenced to some extent by school training and information. Because the fundamentals of the usual types of "school" information are usually fully learned by the age of fifteen or sixteen, measures of innate capacity by means of tests which are influenced by

² C. A. Richardson and C. W. Stokes, *The growth and variability of intelligence*, *British Journal of Psychology Monograph Supplements*, 1933, No. 18, p. 83.

such information are valueless during adulthood. As we shall see later, F. N. Freeman believes that mental growth continues in some individuals for a longer period of time than in others. There is no parallel, however, between the length of time that physical growth continues and that of mental growth. Recent evidence has shown that in retarded and defective individuals mental growth continues beyond the level at which the average child ordinarily matures, although the rate of growth becomes slower after the age of sixteen.

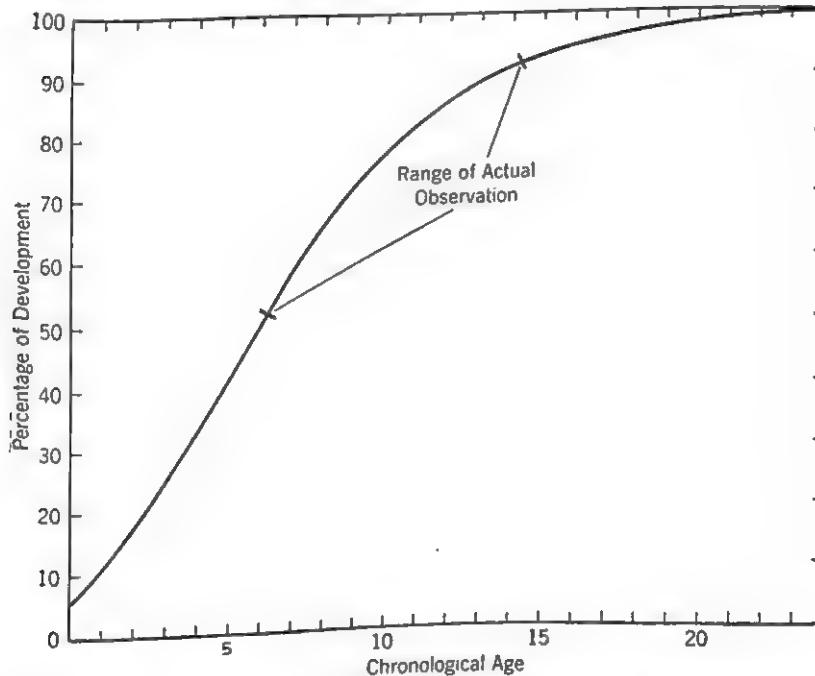


Figure 4. Mean Percentage Growth Curve of Ability, with Extrapolations
(From Richardson and Stokes, p. 31)

The Shape of the Mental Growth Curve

Most of the mental growth curves which are based upon cross-sectional studies are ogival or parabolic. Wilcocks,³ how-

³ R. W. Wilcocks, On the distribution and growth of intelligence, *Journal of General Psychology*, 1932, 6, 233-275.

ever, reported a study on over sixteen thousand children in South Africa from which contrary evidence was obtained. A group test was given to children ranging in age from 120 to 192 months. The results, according to Wilcocks, showed that growth of intelligence for ages 120 to 192 months may be expressed by a hyperbolic equation. In the study of Richardson and Stokes, the entire population of children between six and fourteen years of age of an English town was tested. The data were evaluated by the method of Thurstone's absolute scaling. The results showed that the mean growth curve was almost a perfect ogive curve. By the method of extrapolation, the curve below the age of six showed an inflection at shortly after the fourth birthday. When this method was applied at the upper end, it showed that development probably reaches about 96 per cent at eighteen years.

Many of the critics of the psychologists who have constructed curves of mental growth based their opinions upon the probability that the cross-sectional method does not measure individual growth. For this reason there has been an increase in interest in intelligence testing by measuring the performance of the same children over a long period of time. Such a study was made by Freeman⁴ and his co-workers at the University of Chicago Laboratory Schools. Several hundred children were tested annually on vocabulary, analogies, completion, and opposites tests (symbolized by the investigators as VACO). These tests were of children from eight years of age to late adolescence. In general, it was found that the rate of increase in ability was relatively constant from eight to fifteen years. The average growth curve was thus linear with a slight dropping off at about the age of fifteen. The curves for each of the four tests roughly resembled the composite. It was significant that no marked negative acceleration occurred, indicating, perhaps, that intellectual growth might continue beyond the age of six-

⁴ F. N. Freeman and C. D. Flory, Growth in intellectual ability as measured by repeated tests, *Monographs of the Society for Research in Child Development*, Vol. II, No. 2, 1937, Washington, D. C., National Research Council; F. N. Freeman, Intellectual growth of children as indicated by repeated tests, in *Psychological studies of human variability*, Edited by Walter R. Miles, *Psychological Monographs*, 1936, 47, 20-34; F. N. Freeman, Individual differences in mental growth, *Scientific Monthly*, 1933, 37, 263-266.

teen. The data also showed that the rate of growth of the brighter pupils decreased at the upper age levels and those of lower ability showed a more constant rate of growth, but none of them had reached a maximum at the end of the high-school period.

Somewhat contradictory findings to those of Freeman were reported by Pintner and Stanton.⁵ They gave the CAVD test annually to 140 children from grades one to eight. This test was used because each unit of the scale is equal in difficulty to any other unit. On the CAVD tests it is as difficult to gain a point at one level of the scale as at any other level. The authors stated that there was a slight decrease in the average gain of intelligence from year to year. Thus, the general growth curve was parabolic rather than a straight line. Such data confirm the general belief that innate intelligence ceases to develop at about the age of fifteen or sixteen. If a linear curve were employed to denote the growth of intelligence, it would hardly be plausible to explain the supposed sudden stop in growth. Freeman,⁶ however, stated, "the age-growth curve seems to approach much more nearly a straight line than a logarithmic curve, within the limit of those ages for which a particular test is well suited, and up to the period of adolescence." The question may well be asked why the development suddenly changes at adolescence from the type represented by a straight line.

It is quite clear that the kinds of growth curves which are proposed depend to a large extent upon the kinds of measures of mental ability which the various investigators use. The nature of a given growth curve also depends upon the number of items in the tests and upon the kinds of units which the tests represent. Thus, ordinary mental-age tests may give a different kind of growth curve than raw score tests, and different raw score tests may give different growth curves.

The discussion regarding the differences of variously proposed growth curves might well be considered "academic," except for the fact that the acceptance of one or another of these

⁵ R. Pintner and M. Stanton, Repeated tests with the CAVD scale, *Journal of Educational Psychology*, 1937, 28, 494-500.

⁶ F. N. Freeman, Mental tests, 1939 (rev.), Boston, Houghton Mifflin Co., p. 296.

curves may influence the training and educational programs of children. If growth ceases at the age of sixteen and if there is a gradual decrease in the rate of growth from an early age, the training and educational programs might certainly be different than when we postulate a linear growth curve with a continuation of mental development well beyond the sixteen-year-old level. Furthermore, the prediction for the final development of a child may determine his educational fate as well as his vocational training. This may be especially significant in cases of retarded or defective children.

Components of Growth Curves

Growth curves presumably represent the relationship between chronological age and the level of general intelligence. In the discussion on general intelligence it was stated that intelligence represents an average of a number of abilities. The difficulty in constructing a growth curve which represents general intelligence is essentially a difficulty of utilizing any one test to represent these abilities. Individual tests usually emphasize several factors, such as verbal and numerical abilities. The result is that a curve of mental growth constructed on the basis of a given test, or even on a group of tests, represents merely the growth of a given number of abilities rather than the growth of the composite of all abilities, which is general intelligence. This accounts, in part, for the different growth curves which different investigators have constructed, that is, as a result of using different tests.

The problem of the construction of the growth curve is also complicated by the difficulty in testing those abilities which develop at different rates. Many abilities which develop gradually are differentially measurable only at wide age intervals. Some abilities do not develop until the child reaches a given age, such as verbal ability, which naturally cannot be measured in infants younger than a year. In the newborn infant the most common measure of intelligence is the adequacy of sensorimotor responses. Because many sensori-motor responses mature at an early age, it is impossible to continue their measure-

ment after a given age. For this reason some investigators believe that the growth of intelligence should be represented by a number of curves representing different abilities. Some of these abilities may be measurable from early infancy to adulthood whereas others may be measured either before or after a given age level.

The intelligence of an individual can obviously be estimated only by measuring his performance. The nature of the performance differs at different age levels. The differences are most significant during the first few years of life. The earliest type of adaptive activity is dominantly of the reflex type.⁷ Although most of the reflexes can be observed in the newborn, not all are adequately developed. The sensori-motor activities which develop rapidly after birth function mainly as defense reactions. These early sensori-motor reactions are similar to the defense reflexes of animals. In a relatively short time a large number of additional sensori-motor reactions develop, such as coordinated responses to sound and light, and coordinated and combined movements of the head, arms, and legs. As these gross sensori-motor reactions become perfected, the integration of skillful voluntary muscular activity develops. This is illustrated in the appearance and rapid development of manipulatory activities. These manipulatory abilities are well under way to perfection when language develops. It is at this time that concepts and abstract mental activity rapidly develop. These phases are not specifically circumscribed but overlap to a great degree. Nevertheless, each develops as the previous phase is nearing perfection. The measurement of each phase has great predictive value, for if an infant is retarded in one stage of its development, it can be predicted that the succeeding stage will also show retardation.

The increasing adaptive adjustment of the newborn infant is to a large extent due to the increasing dominance of the cortical areas. The newborn infant is in many ways subcortically dominated, and its activities are controlled by brain areas which are phylogenetically old. This is illustrated by the new-

⁷ M. Sherman, I. Sherman, and C. D. Flory, Infant behavior, *Comparative Psychology Monographs*, 1936, 12, No. 4, Baltimore, Johns Hopkins Press.

born's unregulated and uncoordinated activities, the relatively meager repertoire of adaptive responses, and the presence of pathological reflexes, such as the positive Babinski and ankle clonus. The rapid assumption of cortical dominance is illustrated in the rapid increase of the number of adaptive reactions, the disappearance of the pathological reflexes, and the development of integrative and correlative activities. The functional organization of the cortex in some ways precedes and to some extent is independent of some phases of structural development.⁸ As the cortex assumes dominant control, its regulatory and inhibitory functions play an important role in developing integrated behavior.⁹ This does not mean, however, that the subcortical areas no longer have important functions. On the contrary, many important activities continue to have their origin in these areas.

Early Development

The clearest index of the intelligence of the young infant is the development of a variety of sensori-motor responses and the rapid increase of their adaptive adequacy. These responses develop in an orderly sequence, and it is possible to predict the intellectual development from an estimate of the level of development at a given age. Shirley¹⁰ has shown that many types of development follow a definite pattern. Postural and locomotor development proceeds as follows: passive postural control, active postural control, active efforts toward locomotion, locomotion by creeping and walking with support, and finally walking alone. Each phase is marked by several stages which can be fairly accurately defined. Gesell¹¹ was one of the first investigators to chart systematically this early sequence of development. He constructed a scale of intelligence on the basis of his observations of the sequential growth of sensori-motor ade-

⁸ K. S. Lashley, *Brain mechanisms and intelligence*, 1929, Chicago, University of Chicago Press.

⁹ C. J. Herrick, *Brains of rats and men*, 1926, Chicago, University of Chicago Press.

¹⁰ M. M. Shirley, *The first two years: A study of twenty-five babies*, Vol. I, *Postural and locomotor development*, 1931, Minneapolis, University of Minnesota Press.

¹¹ A. Gesell, *Infancy and human growth*, 1928, New York, The Macmillan Co.

quacy. Reference will be made to Gesell's method of testing the intelligence of infants in a later discussion dealing with testing procedures.

The improvement in motor ability and dexterity is accompanied by a rapid development of sensory discrimination. This is natural since posture, locomotion, and manipulation depend upon the integration of muscular activity with the proprioceptive sensations arising from these movements as well as a co-ordinated functioning of various sense organs. There is also an orderly sequence in the development of adequate coordination between the exteroceptive senses and muscular activity. This is seen, for instance, in the gradual improvement in the accuracy of reaching for an object or in moving toward a specific sound.

Some contrary evidence has been presented by Fillmore¹² which indicates that the results of tests during early infancy do not correlate with the I.Q.'s obtained later on. This may be due to the fact that the intellectual responses during infancy are not of the same order as the verbal responses on tests from which intelligence is estimated in children. One of the difficulties of testing the abilities of infants is due to the great overlap of the functions which are measured. For instance, in most tests motor coordination is measured as well as sensory acuity, adaptability, and learning. Alertness and motor ability are thus apparently the most common items of tests for infants. Richards and Nelson¹³ showed this when they subjected Gesell's test to factorial analysis. Thus, it can be inferred that tests at a later period will not necessarily measure the same processes that are measured during infancy. Bayley's¹⁴ study was also significant from this standpoint. She gave 61 infants, ranging in age from one month to three years, tests at each month. The tests included adaptability or learning, sensory acuity, and fine motor coordinations. It was obvious that the tests measured different

¹² E. A. Fillmore, Iowa tests for young children, *University of Iowa Studies in Child Welfare*, 1936, 11, No. 4, Iowa City, University of Iowa.

¹³ T. W. Richards and V. L. Nelson, Studies in mental development: II, Analysis of abilities tested at the age of six months by the Gesell schedule, *Journal of Genetic Psychology*, 1938, 52, 327-331.

¹⁴ N. Bayley, Mental growth during the first three years, *Genetic Psychology Monographs*, 1933, 14, 1-92.

functions or groups of functions at successive age levels rather than units of intelligence. During the first six months the measures are largely sensori-motor, and after that period the infant becomes more adaptive and thus different tests must be employed. The curve of mental growth constructed on the basis of these tests showed a positive acceleration during the first seven or eight months, followed by a slight negative accelera-

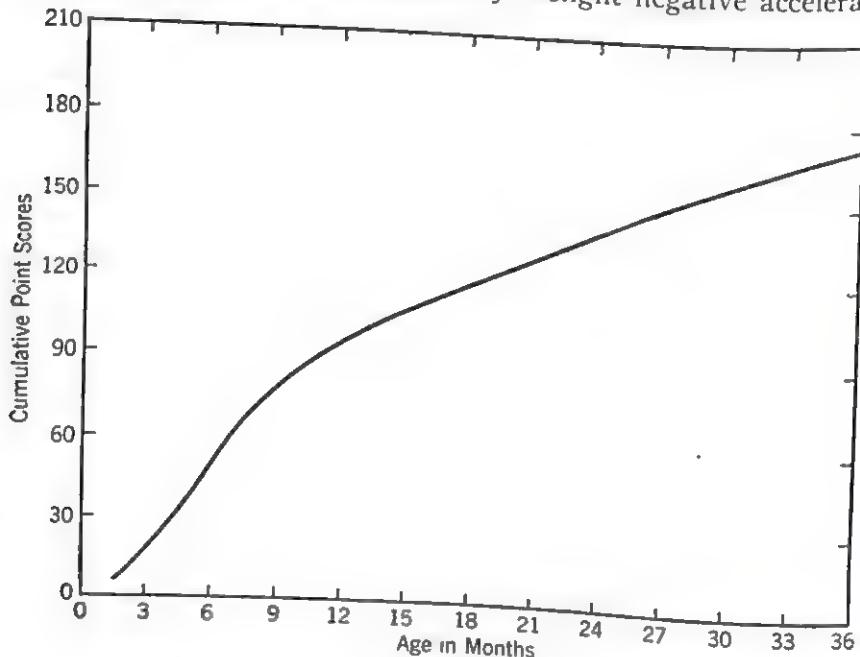


Figure 5. Mental Growth Curve: Cumulative Point Scores
The curve illustrates the rapid change in scores during the first year. (From Bayley, p. 39)

tion, and in turn by a comparatively constant rate. According to Wellman, motor development beyond the period of two years indicates a negative acceleration at the ninth and tenth years, and acceleration also occurs at ten to thirteen years.¹⁵

Mention has already been made of the fact that some sensori-motor reactions mature during early childhood although the

¹⁵ B. L. Wellman, Motor development from two years to maturity, *Review of Educational Research*, 1936, 6, 49-53.

acquisition of motor skills may continue for a long period, depending upon the training the individual receives. In determining mental growth it is necessary to distinguish between the development of sensori-motor ability and acquired proficiency which may to some extent be dependent upon this ability. Thus, it is difficult to measure differences between the sensori-motor reactions of adolescents or adults, whereas manipulative dif-

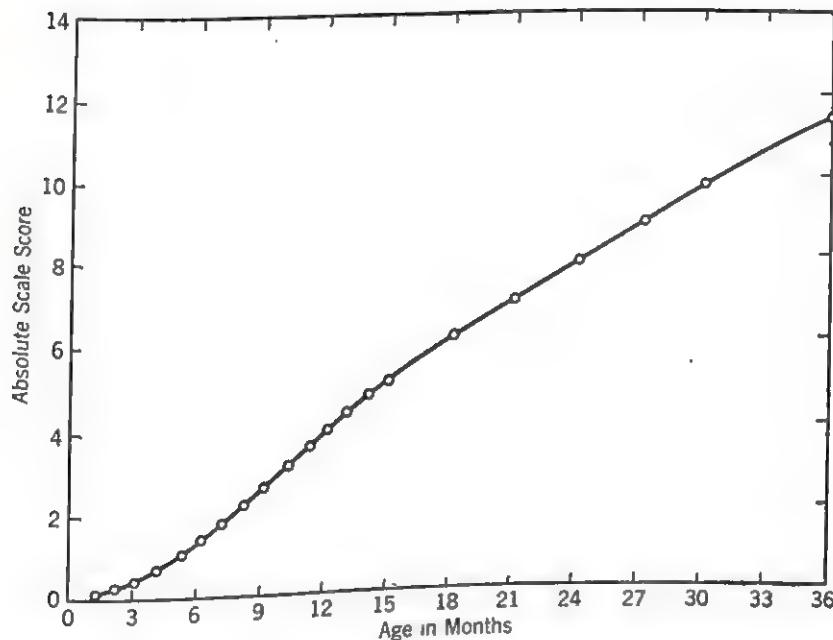


Figure 6. Mental Growth Curve: Thurstone Absolute Scale
Note the positive acceleration during the first seven or eight months. (From Bayley, p. 43)

ferences are measurable. Because given phases of sensori-motor reactions mature during infancy, it is impossible to differentiate between children of low and high intelligence by measures of sensori-motor abilities. Defective children can learn simple sensori-motor habits or skills as quickly as very intelligent children, but their manipulative and verbal reactions are defective.

Even before the rate of sensori-motor development decelerates, verbal ability becomes an important item in the individual's

adaptive responses, and therefore an important factor of intellectual growth. The development of speech and language is a symbolic process, as a result of the increasing integrative action of the cortical areas. The sequence of the development of various types of reactions is illustrated in the defective as well as in the normal child. When the sensori-motor responses are retarded, speech and language also are retarded. The child who walks at sixteen months develops a higher level of general intelligence than a child who first begins to walk at the age of two and still higher than the child who walks at three years. The only exception to this gradual and orderly sequence of development is seen in gifted children in whom Terman found that talking frequently precedes walking by a few weeks.¹⁶ Similarly, when there is delay in the development of language, the development of the child's concepts is also delayed.

The short period from birth to the maturation of sensori-motor responses makes it difficult to use the results for predictive purposes. Bayley reported that behavior tested in early infancy is not accurately predictive of later intellectual development. Nelson and Richards reported that the Gesell schedule at six months is not predictive of the mental development as measured by the Merrill-Palmer test at the age of two.¹⁷ They examined 123 children at the six-month birthday and later correlated the results with those obtained on the Merrill-Palmer tests at the age of two and with the results of the Stanford-Binet scale at three. The coefficient of correlation between the Gesell tests and the Merrill-Palmer was +.37 and with the Stanford-Binet, +.46. The low correlation is due in part to the shifting of the relative importance of functions which the tests measure at successive age levels. It is also possible that different aspects of mental growth do not develop as parallels during the first few years of life. Thus, with increasing age, the tests con-

¹⁶ L. M. Terman and others, Mental and physical traits of a thousand gifted children, *Genetic Studies of Genius*, Vol. I, 1925, Stanford University, Cal., Stanford University Press.

¹⁷ V. L. Nelson and T. W. Richards, Studies in mental development: I, Performance on Gesell items at six months and its predictive value for performance on mental tests at two and three years, *Journal of Genetic Psychology*, 1938, 52, 303-325.

tain fewer manipulative items and a larger number of items involving distance perception and awareness.

An individual growth curve may be plotted for language development, which is a much more complex ability than, but dependent upon a given degree of, sensori-motor adequacy. Although language becomes an important adaptive factor at about one year, the basic linguistic process probably starts much earlier. According to some investigators, development is rapid at first and begins to slow down at about the sixth to the seventh year. The development of language, like the development of other abilities, shows definite stages of growth, beginning with words and passing through phrases and sentences.¹⁸ It is not easy, however, to measure the increments of linguistic growth because, although vocabulary may increase indefinitely, the use of the vocabulary is one of the main criteria of intellectual development. It is through language that we are able to measure complex mental functions, that is, it is a criterion of the functioning of concepts and abstractions which cannot be measured in other ways. The curve of linguistic growth probably has many components. These components develop in a parallel way rather than by successive accretions. The existence of many components creates a special difficulty in the attempt to measure intelligence by complex tests involving language. The more rapid differentiation of some elements makes it impossible to construct accurate tests. For example, scores on memory tests have been shown to increase from nine to twelve years but do not significantly increase from twelve to fifteen years of age. Scores on vocabulary and arithmetic tests, on the other hand, show an increase until the fifteen-year level.

In summary it may be said that the curve of mental growth is usually a composite curve of many abilities, some of which differentiate early and some of which differentiate later. It is composed of at least several successive, independent but overlapping growth curves—the curve of growth of sensori-motor abilities, of language, and of concepts. The most complex of these growth curves is one involving the formation and mani-

¹⁸ D. McCarthy, Language development, in *A Handbook of Child Psychology*, edited by Carl Murchison, 1933, Worcester, Clark University Press, pp. 329-373.

festation of concepts and is probably a composite of many parallel and differential growth curves.

Duration of Mental Growth

One of the major problems which has confronted investigations of intelligence testing is that of defining the duration of mental growth, that is, the point at which the growth curve reaches its asymptote. The early Stanford revision of the Binet-Simon scale considered sixteen years the age at which mental growth supposedly ceased. Theoretically, the growth curve reaches its maximum at the age at which an unselected sampling of the population fails to show improvement. One of the major difficulties has been to obtain a true representation of the population. When school children are tested, it is necessary to contend with a large number of disturbing factors. As an example, dull children may be forced out of school at an early age whereas bright children may complete their schooling at an earlier age than the average. Consequently, a sampling of young children will include both dull and bright children, whereas a sampling of fifteen- or sixteen-year-olds may include only relatively few retarded children. When children fourteen years of age are tested in the eighth grade, only few bright children may be included because they will have graduated at an earlier age.

On the new 1937 Terman revision of the Binet-Simon scale it was found that the yearly gain in score became relatively small about the age of fifteen. After fifteen the mental-age score showed only a slight tendency to improve. This means that mental growth is very slight at the age of fifteen, and a noticeable decrease in rate begins at about thirteen. Other investigators have concluded differently on the basis of their testing programs regarding the age at which mental growth supposedly ceases. In one study in New England, in which the Army Alpha test was used, it was found that the rate of mental growth decreased gradually from about eighteen to twenty-one. In the same study it was also found that persons above the age of eighteen tended to show gains in their scores when special tests were used. Such gains after the age at which mental growth

supposedly ceases were reported by McConnell.¹⁹ He tested seventy college seniors on the 1928 edition of the American Council on Education Psychological Examination. They were originally tested as freshmen on the 1927 edition, and these scores were transmuted for comparison with the 1928 tests. The seniors were found to show an average gain of 40 points over their comparable scores as freshmen. There was thus considerable displacement in rank from freshman to senior year although the coefficient of correlation between the two tests was .83. Those in the lower half of the original distribution gained more in score than those in the upper half. Similarly, when the Thorndike Intelligence Examination was given to Bryn Mawr College students, the results showed a significant improvement in the scores.²⁰ The findings were utilized as evidence that general intelligence improves beyond the age of eighteen.

Freeman and Flory,²¹ employing the longitudinal method of study, concluded that intellectual growth does not cease by the age of seventeen and probably continues for a much longer period. The growth curves they obtained showed no marked negative acceleration by the age of sixteen, which possibly indicated that mental growth continued well beyond that level. None of the subjects had reached the maximum by the end of the high-school period, and a group retested in college still showed definite improvement in test scores. Freeman and Flory concluded that the end point of intellectual development has not been definitely ascertained by any existing studies.

A number of investigators have pointed out that the difficulty of defining the end of the growth curve is due to the types of tests which are used. The growth of native intelligence is considered stopped when test scores at succeeding age levels show no gains. This supposes that the tests which are usually employed are true measures of ability, independent of acquired

¹⁹ T. R. McConnell, Changes in scores on the psychological examination of the American Council on Education from freshman to senior year, *Journal of Educational Psychology*, 1934, 25, 66-69.

²⁰ A. L. Rogers, The growth of intelligence at the college level, *School and Society*, 1930, 31, 693-699.

²¹ F. N. Freeman and C. D. Flory, Growth in intellectual ability as measured by repeated tests, *Monographs of the Society for Research in Child Development*, Vol. II, No. 2, 1937, Washington, D. C., National Research Council.

information and specialization. In addition, in a number of studies high-school graduates and college students were selected for testing and therefore errors of sampling obviously influenced the results. It is obvious that high-school and college students constitute a sampling of the more intelligent of the population. It is possible that the superior individual continues to improve in intellectual ability for a longer period than the average individual. This sampling difficulty was met in part by Freeman and Flory, who showed among their findings that the duller children tended to improve for an even longer period than the brighter. The types of tests used by Freeman and Flory, however, may have allowed the duller children to gain more than the brighter.

Individual Variations

It is necessary to explain why individuals differ so greatly from each other. Because of this variability, the question arises whether predictions can be made regarding the rate of intellectual growth, and the problem of prediction involves the question of the constancy of the I.Q. Freeman and Flory divided their subjects into three groups according to relative brightness. They then compared the curves of growth of these three groups. From the ages of nine to thirteen the rates of growth varied, that is, the highest group accelerated, the middle group had less acceleration, and the lowest group was almost uniform. From thirteen to sixteen the curves of the groups were more nearly parallel. Still later the brightest group showed a decreasing rate of growth whereas the lower ability group showed a more constant rate of growth. Although none of the three groups reached the maximum, the differences suggested that the lower groups would continue to advance as long as and perhaps longer than the brighter. As suggested previously, the sampling was not adequate. The average I.Q. was considerably above 100, and none of the groups was below normal. They thus did not represent bright, normal, and dull children.

Evidence contrary to that of Freeman and Flory has been obtained in other studies, especially in investigations of men-

tally dull children. Wheeler²² studied a small group of children with I.Q.'s below 90. The median for the entire group was approximately 83. Each child was retested every twelve months for four consecutive years. The group as a whole showed a decreasing increment of mental growth with chronological age increases. At the age of six the average retardation was 11.7 months and rose until at the age of ten, when the average retardation was 29.3 mental months. Thus, the dull children developed more slowly than the normal children, and the longer the dull child remained in school the more retarded he became. These findings do not mean that there was a direct change of the I.Q.'s, since an increase in the degree of school retardation may not necessarily indicate a lowering of the I.Q.

A survey of consecutive test records at Vineland showed that borderline defectives were heterogeneously distributed. A study was made of fifty children with I.Q.'s of 75 or higher. They were found to fall into three main groups: (1) The potentially feeble-minded who were not recognizable by tests at an early age. These children showed a progressive retardation. (2) The true borderline children in whom the I.Q.'s fluctuated irregularly. (3) Cases of delayed development. These children showed slow, steady mental growth long after the final level should have been attained. They finally developed into the low or average normals. Curves of growth were different for the different groups, and the I.Q. was generally inconstant. The age of maturity of development also varied. Some matured prior to fourteen; others showed variable levels of maturity extending to the twenty-year level; and a third group matured at a still later age.²³ According to many reports, "true" feeble-minded children show a consistent decline in mental growth. Kuhlmann²⁴ reported that the yearly increase in the mental age of the feeble-minded person depends upon the degree of mental deficiency. In general, the I.Q.'s of the more defective children

²² L. R. Wheeler, A study of the mental growth of dull children, *Journal of Educational Psychology*, 1930, 21, 367-378.

²³ E. J. Jewell, The mental growth of borderline feeble-minded, *Training School Bulletin*, 1929, 26, 38-42.

²⁴ F. Kuhlmann, The results of repeated mental re-examinations of 639 feeble-minded over a period of ten years, *Journal of Applied Psychology*, 1921, 5, 195-224.

decline to a lesser degree than those of children with a higher grade of mental deficiency. Usually mental age ceases to increase at between fifteen and eighteen years. The idiots, however, cease to develop about three years earlier than the borderline defectives. About 68 per cent of the children gained from one to eleven months during the year; 16 per cent lost from one to seven months during the year. Other reports have also shown that most of the mental growth shown by idiots appears before the age of ten with very little progress past the fourteen-year-old level. Not only does the mental growth of the idiot cease, but most of them also show deterioration after fourteen years, and their I.Q.'s tend to drop considerably with age.²⁵

The variability in I.Q. of superior children appears to be greater than that of the defective. Terman showed that I.Q.'s tend to increase with age in children whose I.Q.'s are above 140. An analysis of the Binet retest scores in the Harvard growth study, however, failed to confirm the findings of Terman. These findings showed that children with I.Q.'s above 120 tended to be the least consistent.²⁶ Of this group, approximately 46 per cent of the boys and 41 per cent of the girls gained, and approximately 51 per cent of the boys and 54 per cent of the girls showed losses. Cattell²⁷ believed that pupils of high intelligence tend to gain and those of low intelligence tend to lose in I.Q. as they become older. There appears to be no significant difference in this gain between bright, dull, or normal children. In a review of the literature on superior children, Nemzek²⁸ reported that there was a definite tendency for the I.Q.'s to increase. He also reported that the studies generally have found a high degree of consistency both on the Stanford-Binet and on group tests. Jordan²⁹ also indicated that I.Q.'s tended to become constant at different levels. He tested a group

²⁵ L. Moore, Mental growth of low grade feeble-minded, *Training School Bulletin*, 1929, 26, 88-95.

²⁶ E. A. Lincoln, Stanford-Binet I.Q. changes in the Harvard growth study, *Journal of Applied Psychology*, 1936, 20, 236-242.

²⁷ P. Cattell, Constant changes in the Stanford-Binet I.Q., *Journal of Educational Psychology*, 1931, 22, 544-550.

²⁸ C. L. Nemzek, The constancy of the I.Q., *Psychological Bulletin*, 1933, 30, 143-168.

²⁹ A. M. Jordan, Mental growth, *Journal of Applied Psychology*, 1930, 14, 517-531.

of children semi-annually during a period of three years, using the Pintner-Cunningham, the Dearborn, and the National Intelligence Tests. The National Intelligence Tests were most frequently used because of the various forms which could be given the children without need of repeating any one test. According to the results, the composite growth curve approached a straight line with a tendency to flatten at the upper end of the curve. When the data were analyzed for the high average, the curves maintained a straight line. It is clear that the kinds of tests which were used, the sampling, and the statistical manipulation of the data tended to determine the nature of the curves. Obviously, a sampling from children above average intelligence will show a different growth curve than from children of low intelligence.

In general, the investigations reported in the literature tend to maintain the belief that within the range of average intelligence the I.Q. remains fairly constant. The I.Q.'s of superior children show less constancy and may vary upwards or downwards. The growth curve of superior children probably is angular to rather than parallel with the normal curve. The defective child, on the other hand, tends to become progressively more backward and to lose in I.Q. points, and the point of maturation varies with the degree of retardation.

Environment and Constancy of I.Q.

The question of the constancy of the I.Q. involves the important problem of the differential effects of various environmental conditions. The effects of the environment will be discussed later, but at the present it might be worth while to discuss briefly the question of I.Q. constancy as illustrated in studies involving environmental differentiation. Of the many studies in this area, the recent investigations of Beth Wellman,³⁰ at the University of Iowa, seem to be the most significant not only from the standpoint of the extent of the investigations but also in terms of the criticisms of her conclusions. Wellman exam-

³⁰ B. L. Wellman, Mental growth from preschool to college, *Journal of Experimental Education*, 1937, 6, 127-138.

ined children at succeeding ages and correlated the scores during the preschool years with the scores obtained on the same individuals when they were in high school and college. Of 78 students who were given college entrance qualifying examinations, 21 had attended a preschool and 57 did not attend. It was found that the persons who had had preschool education made higher scores on qualifying and college examinations. Thus, preschool attendance supposedly directly affected mental ability and resulted in higher scores at the high-school and college ages. A number of significant intellectual changes occurred in many of the children. One child changed from an I.Q. of 98 to 153, and another from 89 to 149. Wellman concluded that under ordinary circumstances groups change very little in I.Q. Under various types of stimulation, however, the change may be tremendous. According to such findings, the mental growth curve shows the functional manifestation of intelligence. The degree of change is determined by the kinds of experiences the individual has, that is, experiences differing from the ordinary. It is not entirely clear whether the mental growth curve is different in different individuals, according to Wellman's theory, or whether predictability cannot be certain because inherent changes may take place as the result of different types of stimulation. One of the most serious criticisms of this concept was made by Goodenough.³¹ The critical analysis which Goodenough made will be mentioned in greater detail later. One statement is, however, significant in relation to the discussion of the constancy of the I.Q. Goodenough stated that Wellman made a serious error in her assumption regarding testing methods and this error may have nullified the interpretations of the findings. The error involves the assumption that the kinds of abilities which are measured at the preschool level are similar to those which are measured at the high-school and college levels. Goodenough pointed out that not only is there a great error in the tests which are given to preschool children but evidence also exists to show that the manifestations of intelligence which are measurable at the preschool level may be entirely different from

³¹ F. L. Goodenough, Look to the evidence! A critique of recent experiments in raising the I.Q., *Educational Method*, 1939, 19, 73-79.

those which are measurable later on. She also emphasized the fact that many experimenters have shown that the coefficient of correlation between the level of ability of very young children and their later scores on ordinary tests is relatively small.

It is possible that the experiences which the nursery school furnishes to a child and the information obtained in higher educational institutions may be so closely parallel that test results may be manifestations in part of the kind of information which the children have gathered rather than indices of their native ability. Except for the results of the University of Iowa investigators, changes in the growth curve which have been reported by a number of observers have been considered due to specific environmental modifications. These changes are not of innate ability but are due to the greater opportunities for normal development under favorable conditions, and the inhibition of innate development under unfavorable conditions. The fact that changes occur under favorable conditions does not contradict the theory of the constancy of the I.Q. Wellman stated that the rapid change of I.Q. is not a denial that the course of mental development takes place in an orderly and predictable fashion.

Anderson³² also criticized Wellman's conclusions. In a review of Wellman's findings, he objected to the implication that native intelligence cannot be accurately measured or predicted because of environmental factors. He recognized the effect of the environment both upon accelerating and decelerating the mental growth of any individual. He pointed out, however, that in many cases extreme variations are found from one test period to another not because of intrinsic variations in intelligence but rather because of variability of achievement. He agreed with others that errors in prediction are often due to the common belief that the intelligence tests administered to a child of three are similar to the tests for a child of twelve. When a child is retested after a number of years, many disturbing factors may enter and chance failures or successes as well as varying opportunities for learning may seriously affect the resulting scores.

³² J. E. Anderson, The limitations of infant and preschool tests in the measurement of intelligence, *Journal of Psychology*, 1939, 8, 351-379.

Anderson also pointed out that the use of chronological age as the only criterion of maturity introduces many disturbing factors. Although chronological age can be easily ascertained and utilized in correlational studies, the mere statement of the age of the individual does not specify the variety of physical, environmental, training, and conditioning factors.

The Mental Growth of the Immature Infant

The term "immature infant" applies to those newborns who are born before the full gestation period or who are not fully developed even though the normal period of gestation has been reached. Some investigators have differentiated between the immature and premature infant. The immature infant is defined as one who at birth weighs less than 2,500 grams and the premature as one who is born before the end of the normal period of gestation. Premature infants are also usually underdeveloped and weigh less than 2,400 or 2,500 grams. Thus, the prematures constitute a particular type of immaturity. In the past it was commonly believed that the premature seldom became normal. Capper, for example, stated that "the immature infant becomes the backward school child, and is a potential psychopathic or neuropathic patient and even a potential candidate for the home for imbeciles and idiots."³³ Capper reported that only one-third of the immature children whom he observed who had reached school age were in classes that corresponded to their chronological ages. The remainder were somewhat retarded. His conclusions were based on rather indefinite criteria. For example, he used as the criteria of mental development the age of sitting, standing, and walking, the age at which the child first attempted to speak, and the adequacy of the recognition of colors, counting, and the naming of common objects. Obviously, this study suffered from two defects; the defects of an unstandardized testing method and of poor sampling. In contradistinction to the report by Capper, other studies of prematures have not justified such pessimistic conclusions. Mohr

³³ A. Capper, The fate and development of the immature and of the premature child, Part II, *American Journal of Diseases of Children*, 1928, 35, 443-491.

and Bartelme³⁴ reported a study of 113 white prematures weighing at birth 2,500 grams or less. They were tested by the Kuhlmann-Binet scale and the Gesell schedule. They reported that the younger children did rather poorly in motor performance but in general the prematures compared favorably with full-term children. This was especially true if a correction was made, in terms of age, for the degree of prematurity. They also reported a rapid growth during the first two to three years. An additional report was made by Hess, Mohr, and Bartelme³⁵ of a study of 250 prematures. In general, the results confirmed the earlier report. On the Gesell scale 43 per cent were found to be average, 35 per cent below average, and 22 per cent above average. Premature birth unassociated with intracranial injury apparently did not affect mental development.

Many prematurely born children tend to be retarded during the first two or three years. Later, however, they compare favorably with full-term children. There is thus very little difference between the premature and the full-term child following the period during which the original lack of development because of the shorter period of interuterine life is compensated for by the learning process.³⁶ The high frequency of mental retardation and deficiency in prematurely born children is probably due to their greater susceptibility to birth injuries and diseases rather than to the factor of prematurity. The problem is somewhat different in immature infants. In those cases there is a general retardation of the rate of development, and this retardation may result both in physical and in mental defects.

Mental Decline

In recent years psychologists and psychiatrists have interested themselves in intensive studies of adult intelligence. They have been especially interested in the problem of the decline of

³⁴ G. J. Mohr and P. F. Bartelme, Mental and physical development of children prematurely born, *American Journal of Diseases of Children*, 1930, 40, 1000-1015.

³⁵ J. H. Hess, G. J. Mohr, and P. F. Bartelme, The physical and mental growth of prematurely born children, 1934, Chicago, University of Chicago Press.

³⁶ See M. Comberg, The fate and development of premature infants up to early school age, *Ztschr. f. Kinderh.*, 1927, 43, 462. (Abstract in *American Journal of Diseases of Children*, 1928, 35, 905.)

intelligence. Everyone knows that adults learn some kinds of material less easily than children. The available data have not fully answered the questions regarding the time mental decline begins, how quickly it progresses, and to what level the average person declines. These problems have been studied in three ways: (1) by evaluating the results of intelligence tests, (2) the measurement of learning ability, and (3) an evaluation of the ages at which the greatest productivity occurs.

A number of studies have been made with intelligence tests, especially group tests of mental ability such as the Army Alpha and the Otis Self-Administering test. Most of the studies have shown that there is a leveling off between the ages of twenty and twenty-five and that the decline is slow but steady.³⁷ A number of criticisms have been made of the use of intelligence tests as a measure of adult ability. It is well known that tests such as the Alpha and Otis measure alertness rather than real intelligence, that is, they measure acquired ability on the basis of innate capacity. It is well known that individuals vary greatly regarding the information in which they show a great deal of interest. In adulthood interests narrow and there are likely to be gaps of information and a great deal of variability between individuals. It has also been shown that adults cannot be motivated as easily to intensive effort in test situations, and they are therefore likely to fail more readily. The majority of adult tests are speed tests, that is, they have time limitations. It is probable that the decline in motor reactivity may have some effect upon the test results.

Studies of adult learning have shown a decline after the age of twenty-five or thirty, according to some investigators, and after the age of forty or fifty, according to the results of some studies. It is understandable that the adult will not be able to learn given skills as rapidly as the adolescent, to a large extent because of lessened speed and sensory acuity. The older the individual the slower he tends to become physically and the higher the threshold of his sensory processes. There is another

³⁷ See H. E. Jones and H. S. Conrad, *The growth and decline of intelligence: A study of a homogeneous group between the ages of ten and sixty*, *Genetic Psychology Monographs*, 1933, 13, 223-298.

factor, however, which affects the learning ability of adults and which is unrelated to basic intelligence. This involves the difficulty of learning a problem which interferes with a previous motor or sensory set. This is true of children as well as of adults, but obviously children have not developed as many fixed patterns as adults. In one of a number of experiments conducted by Thorndike and his co-workers,³⁸ six subjects were given practice in writing with their left hands, and two persons who were left-handed wrote with their right hands. They ranged in age from twenty-two to fifty-two years. A preliminary test was given and was followed by 30 practice periods of 30 minutes each. A final test was given to measure the learning. A second experiment with 33 adults but shorter practice periods was also conducted. The results showed that the older subjects learned to write fewer letters, but the quality of their writing was better. In other words, although the speed of the younger subjects was greater, they were probably not as careful or as able to form accurate letters.

Data on productivity indicate that mental decline takes place somewhere between thirty-five and forty. Studies of scientists, psychologists, and inventors have shown that the greatest output occurred between the ages of twenty-five and forty, and thereafter there was a slow decline.³⁹ On the other hand, studies of authors have shown that the most productive years were between forty and fifty. Data on productivity are not to be considered as evidence for a theory regarding mental decline of the average person. Naturally, these data were gathered on persons far above the average, and interpretations were made as if a random sampling of the population had been obtained. The factor of decrease of interest may play an important role in the decline of productivity, and loss of motivation also probably affects the output of adults. Generally, the people on whom these studies have been made were economically more secure as they grew older, and it is well known that economic security tends to decrease motivation to productivity. In evaluating

³⁸ E. L. Thorndike, E. O. Bregman, J. W. Tilton, and E. Woodyard, *Adult learning*, 1928, New York, The Macmillan Co., pp. 32-46.

³⁹ See H. C. Lehman, *The creative years in science and literature, Scientific Monthly*, 1936, 43, 151-162.

productivity the interpretations are necessarily subjective except for measures of quantity. A great deal of criticism has been directed toward the evaluation of productivity in terms of the quantitative output. It is plausible to believe that a person's productivity may increase by a qualitative improvement of his work in spite of a quantitative decrease. Indeed, many people firmly believe that as a person matures and as his work improves he is usually likely to decrease his output but to improve the quality of his work.

Chapter 3

INTELLIGENCE AND PHYSICAL DEVELOPMENT

Brain Structure and Intelligence

Most investigators in the past assumed that a direct relationship existed between physical and intellectual development. If a mentally defective child was found to be physically normal, the cause of the mental defects was considered due to some structural or anatomic defect of the brain which was of such a nature that it did not manifest itself in a neurological disorder. The intimate relationship between the central nervous system and general mental development has been recognized by many neurologists. Nevertheless, many errors have arisen because this relationship has frequently been misinterpreted. No one can deny that specific disturbances and defects of the brain have definite effects upon intelligence. The microcephalic child, for example, does not have a sufficient number of brain cells to allow him to develop adequate intelligence. As we shall see later in the discussion of specific types of mental defects, the hydrocephalic child is also unable to develop normally for the same reason, that is, because of a deficiency due to destruction of brain tissue.

The association areas of the cortex are obviously the most important areas which influence intellectual growth. Nevertheless, the association areas cannot remain independent of the various projection areas and of the functional interrelationships between the sensory projection and motor projection areas. Perceptual defects due to central nervous system lesions are as effective in producing performance deficiencies as peripheral defects. In the changes occurring in phylogenetic ascent, we may observe the gradual centralization and concentration of nervous system activity within the association areas of the

brain. The brain gradually assumes greater and greater relative mass and function, until in man the ratio between the brain and the spinal cord is positive, whereas in the lower animals the ratio is a fraction. The evolutional development of the brain of man involves changes particularly in the cortex. These changes are complex and various, but one of the most important is the reorientation of the projection areas in relation to the association areas. As an example, the brains of some of the lower animals contain olfactory centers which are larger in area than all the other projection areas. The occipital projection center is very large in some animals. Whereas the olfactory projection area in the frog is extremely large and important, the olfactory center of man is small and is of relatively little adjustmental importance. It is obvious that the evolutional process parallels the functional process. Thus, olfaction has but little importance for man in influencing an adequate adjustment to his environment, whereas vision and audition still remain dominant factors. Even such centers as those for vision and audition are at times relatively unimportant when compared to their importance for the adaptive behavior of many animals.

The symbolic forms of adaptation which man utilizes are relatively, if not entirely, absent in animals. Their responses are immediate and on a perceptual motor level, whereas all sorts of interpolations occur in man, that is, between perception and motor adaptive responses. It is true, of course, that the range of adaptation which the function of the projection areas allows does have an influence upon performance which is essentially intellectual. The compensatory mechanisms of man are so wide, however, that even with basic defects sufficient compensation takes place to allow an individual to maintain his equilibrium or at least to adapt to special environments.

Mention has already been made of the effect of the significant deficiencies of the central nervous system tissue in determining mental deficiencies. In the nineteenth century it was generally believed that a direct relationship existed between brain size and intelligence. Broca, one of the important investigators in this field, failed, however, to substantiate this claim as a result of his studies, and others also showed that within

certain limits the relationship is absent or at least negligible. Claims were made, for example, on the basis of the study of the brains of some distinguished men that actual size plays a dominant role in determining the degree of intelligence, but other studies showed that the reverse relationship may also exist. For instance, the brains of some prominent men, examined on post-mortem, were found to be almost a third below average size. Those who still claimed a direct relationship attempted to explain such findings by maintaining that the association areas are much "richer" in the brains of very intelligent persons, but this claim has never been substantiated by histological examination.

As Paterson¹ has shown, the correlations between head measurement and intelligence are uniformly low. Broom² reported on the relationship between cranial capacity as estimated by external measures on 100 male and 100 female subjects who were given the Thorndike intelligence tests. The coefficient of correlation between the cubic brain capacity and intelligence test scores was only .12. Mention has already been made regarding the claim of some neurologists that the structure of the cortex determines the level of intelligence. It is difficult, indeed, to differentiate one brain from another in terms of the quality of the nerve cells. It is much simpler, on the other hand, to measure the cortex in terms of its thickness and also to determine the concentration of cells by making sample counts. A recent report of this type of investigation was published by Norman.³ Measurements were made of the depth of the supragranular cortex. A count also was made of the nerve cell bodies in this part of the cortex in the brains of 54 mentally defective and 39 normal individuals. Pathological brains were not included in this study, and the defectives were principally of the imbecile and idiot groups. Three areas of the left cerebral hemisphere were examined. In none of the three areas were the

¹ D. G. Paterson, *Physique and intellect*, 1930, New York, D. Appleton-Century Co., Inc.

² M. E. Broom, *Cranial capacity and intelligence*, *School and Society*, 1932, 36, 703-704.

³ R. M. Norman, *Some observations on the depth and nerve-cell content of the supragranular cortex in normal and mentally defective persons*, *Journal of Neurology and Psychiatry*, 1938, 1, 198-210.

supragranular cell layers significantly different in the defectives. Within a given single section, the nerve cell bodies, however, tended to be more irregularly grouped in the defectives than in the normals. The number of cytons per unit area in the brains of the idiots exceeded that of the normal brains. The institutional defectives who were examined showed no particular pathological type of cortical abnormality. Micrometric measurements of the depth of the supragranular layers of the cortex showed no appreciable difference between normal and defective brain sections.

Another study reported within recent years was made by Ashby and Stewart.⁴ They commented on the fact that it is well known that an increase in the size of the corpus callosum is phylogenetically correlated with the simultaneous increase in the mass area of the gray matter of the neopallium. They studied the size of the callosum in 69 fixed brains of 9 normal and 60 defective individuals. They found a coefficient of correlation of .247 between the cross-section area of the corpus callosum and mental age. On the other hand, the three largest belonged to three idiots. When the effect of body weight and brain weight were partialled out, the coefficient fell to .041.

Tredgold,⁵ whose text is probably in most universal use for the study of mental deficiency, claimed, on the other hand, that there are many distinct pathological changes in the brains of mentally defective children. He stated that gross abnormalities of brain structure exist in a considerable number of mental defectives of the lower grades. He also claimed that the reason that other investigators have not found these changes is due to the examination of isolated cases on autopsy. In regard to the cellular condition of the cortex, Tredgold stated that in the defective they are numerically deficient, irregularly arranged, and imperfectly developed. Tredgold gave no quantitative analysis, however, of any of his findings. He merely stated that there are fewer cells which are for the most part haphazardly ar-

⁴ W. R. Ashby and R. M. Stewart, *The brain of the mental defective: a study of morphology in its relations to intelligence, II, The corpus callosum in its relation to intelligence*, *Journal of Neurology and Psychopathology*, 1934, 14, 217-226.

⁵ A. F. Tredgold, *Mental deficiency*, 1929, New York, William Wood & Co.

ranged. Tredgold also emphasized the fact that earlier workers have found that many of the brain cells of the mentally defective individual are incompletely developed as though in some way they remained in a partially embryonic stage. Instead of being pyramidal shaped, they are frequently globular or pyriform. In addition to the cellular changes, Tredgold also claimed that the tangentially coursing fibers of the association areas show a definite diminution in the cases of the low-grade mentally defective. As though in compensation, a good deal of sclerosis occurs.

In general, it may be said that the evidence indicates that in the ordinary mental defective the gross and microscopic organization of the brain differs very little, if at all, from that of the normal individual. Changes are seen on occasions in the low-grade mental defective. The question arises whether these changes or differences are basically the cause of the deficiency or whether they are parallel conditions, that is, whether the brain pathology is one of the symptoms of the general pathology which may be the basis of the mental deficiency. Tredgold assumed more than his evidence substantiated, partly perhaps because it is logical to assume that there must be brain pathology in mentally defective individuals. If it is necessary to believe in a causal relationship between the organization of the central nervous system and the development of intelligence, then such a causal relationship must be thought of in terms other than structure. One can readily understand that permeability, reactivity, speed of impulse, conduction, and other factors may be extremely important for the manifestation of what is known as intelligence. These factors may not be inherent in anatomical structure but may be dependent entirely upon physiological activity and chemical reactions.

Physical Growth and Intelligence

In recent years many studies have been made of the relationship between physical and mental development. The recent studies by Terman indicate that there is probably a parallelism between physical and mental growth. Children of high intelli-

gence tend to develop better physically than children of low intelligence although the relationship is not a very close one. In a fair sampling of the population the extremes show a fairly high correlation.

In a recent review of this problem, Jones⁶ stated that investigations have shown no significant relationship between head size and intelligence or between body development and mental development. A direct relationship between mental and physical growth in preschool children has been reported, however, by a number of investigators. Honzik and Jones⁷ reported on a study of 127 male and 125 female preschool children. They found that individual growth curves showed cases of striking correspondence between mental and physical growth, but others showed none or even an inverse relationship. It is understandable that in the early years of development one might expect to find a close relationship between physical and mental growth, since both types of growth are at their beginning phases and therefore develop in a parallel fashion. In a survey of the literature, Cozens⁸ found that a somewhat positive relation between physical development and intelligence was reported by many investigators for the elementary-school period. During late adolescence and college years, however, very little, if any, relationship existed between physical and mental growth or between physical and mental abilities. A number of studies were made by Dearborn⁹ on the relationship between physical and mental development. In one of these studies intelligence tests and anthropometric data were obtained on pupils for twelve successive years. He found that there was a tendency for the I.Q.'s of superior children to increase and a lesser tendency for the I.Q.'s of the average and retarded children to decrease. The correlations between the I.Q.'s and the anthropometric measures averaged +.06 for girls and +.14 for boys.

⁶ H. E. Jones, Relationships in physical and mental development, *Review of Educational Research*, 1936, 6, 102-123.

⁷ M. P. Honzik and H. E. Jones, Mental-physical relationships during the pre-school period, *Journal of Experimental Education*, 1937, 6, 139-146.

⁸ F. W. Cozens, Status of the problem of the relation of physical to mental ability, *American Physical Education Review*, 1927, 32, 147-155.

⁹ W. F. Dearborn, The mental and physical development of public school children, *School and Society*, 1935, 41, 585-593.

An extensive study was made by Abernethy¹⁰ on the relationship between mental and physical growth. She studied 179 boys and 178 girls from the ages of eight through seventeen at the University of Chicago Laboratory Schools and 140 male and 140 female university students. Thus, she had rather homogeneous groups in regard to economic and educational backgrounds. She studied especially the standing and sitting height, weight, carpal development, chest girth, and lung capacity. She found a low positive correlation between these measurements and intelligence, which decreased after about fifteen years of age. There was no consistent relationship, however, between the amount of gain on psychological tests and the amount of gain in any of the physical traits measured. The average mental and physical growth curves were significantly different, and there was no relationship between fluctuations in the rate of mental and physical development. The correlation between mental test scores and measures of height and weight of adults was negligible. The age of onset of puberty was found to be unrelated to intelligence.

One of the common techniques employed in the attempt to discover the relationship between mental and physical growth is the comparison of children of high and low mental ability. Heaton¹¹ studied two groups of children in a public school, one of high mental ability and the other of low mental ability. He found that the average general level of physical development of children with high intelligence is superior to that with lower intelligence. He reported, however, that there was considerable variation in scores made by individuals of the same group. These findings are in accord with the findings of many other investigators; that is, although children of high intelligence may be physically superior as a group to those of low intelligence, there are so many individual variations and overlappings that no definite statement can be made regarding a direct relationship between physical and mental ability.

¹⁰ E. M. Abernethy, Relationships between mental and physical growth, *Monographs of the Society for Research in Child Development*, Vol. I, No. 7, 1936, Washington, D. C., National Research Council.

¹¹ K. L. Heaton, Physical development of children of high and low mental ability groups, *American Physical Education Review*, 1925, 30, 127-130.

Flory¹² studied mentally deficient children in two state schools for defectives. He concluded that the growth rate of physical traits is slower in mentally deficient boys than in normal boys. In other words, the rate of growth was related to the degree of mental defect. The period of growth of subnormal children was longer than that of normal or superior children. The ultimate size, however, of the mentally deficient children was below that of children who were normal. Flory pointed out that the backgrounds of mentally defective children show many unfavorable conditions. Therefore, the relationships between the physical and mental growth curves may not be indicative of a causal or parallel relationship but merely indices of poor backgrounds. Physical inferiority, for example, is likely to be found in children whose environmental and nutritional backgrounds are poor. Dayton¹³ also studied the relation between physical defects and intelligence. Data were obtained on over 14,000 retarded public-school children. He found that physical defects are more characteristic of children with I.Q.'s below 70 than of children of normal intelligence.

Those who believe in a direct relationship between physical and mental growth have pointed to the frequency of mental retardation among physically defective individuals. Lee¹⁴ studied children in an orthopedic hospital. She found that the intelligence level of that group of children was on the average below that of an unselected physically healthy group of children. In 148 cases she found a range of I.Q.'s from 35 to 138 and a mean I.Q. of 86. No definite conclusions can be drawn, however, from studies of crippled children, in part because many of these children have not had adequate environmental and educational opportunities. Furthermore, residence in an orthopedic hospital influences their performance.

¹² C. D. Flory, *The physical growth of mentally deficient boys*, *Monographs of the Society for Research in Child Development*, Vol. I, No. 6, 1936, Washington, D. C., National Research Council.

¹³ N. A. Dayton, *The relationship between physical defects and intelligence*, *Proceedings of the American Association for the Study of the Feeble-Minded*, 1929, 53, 112-139.

¹⁴ M. V. Lee, *The children's orthopedic hospital: A survey of the intelligence of crippled children*, *Journal of Educational Research*, 1931, 23, 164-166.

As a result of their study, Gordon, Norman, and Berry¹⁵ implied that the nervous system of the mentally defective child is maldeveloped and thus possibly accounts for the low I.Q. Such maldevelopments may also result in physical defects. They

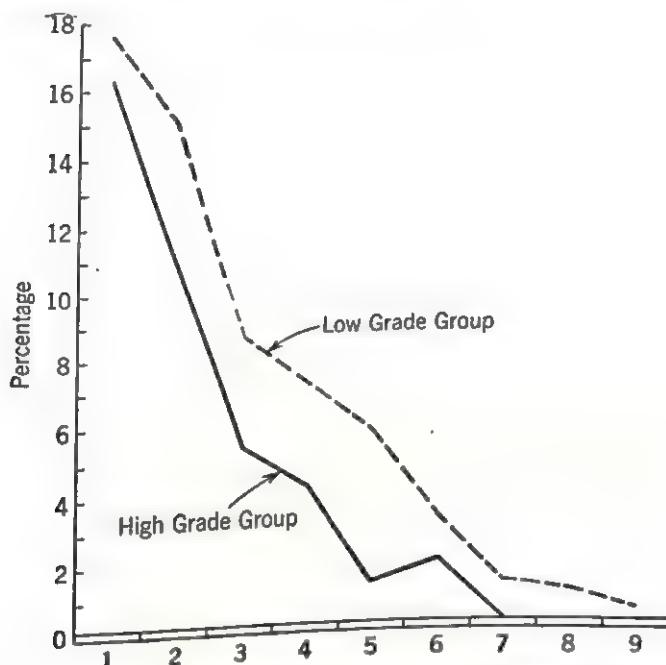


Figure 7. Graph Showing in Low- and High-Grade Aments the Percentage of Occurrence of Nine Signs Clinically Regarded as Symptomatic of Pyramidal Cell or Tract Lesions

It illustrates the tendency for the lower grade group to exhibit more neurological abnormalities. For example, 10.2 per cent of the high-grade group and 15 per cent of the low-grade group exhibited two neurological signs. (From Gordon, Norman, and Berry, p. 103)

found that in a group of 500 mentally defective individuals the percentage of incidence of neurological abnormalities was higher than in normal persons. The lower the mental development the greater was the tendency for the appearance

¹⁵ R. G. Gordon, R. M. Norman, and R. J. A. Berry, Neurological abnormalities: Their occurrence and significance as illustrated by an examination of 500 mental defectives, *Journal of Neurology and Psychopathology*, 1933, 14, 97-107.

of signs of neurological pathology. Many investigators have pointed out that generalizations cannot be made from studies of institutionalized children. Such children are frequently segregated, mainly because they have some physical pathology, and it can therefore be supposed that the frequency of physical defects will necessarily be higher. A child with a low I.Q. who is physically normal can adjust with some adequacy to a normal environment, but a child with a physical defect, however minor, finds a great deal of difficulty in adjusting, and is often institutionalized principally because of his physical inferiority.

When children who are hospitalized for some self-limiting illness are examined, different results are usually obtained. In a study by Dawson and Conn,¹⁶ a group of hospitalized children were compared with their healthy siblings. There was no difference in the I.Q.'s of the two groups. Examination of the patients after their recovery yielded practically the same scores. Also, children with chronic illnesses showed no significant differences. This indicates that when an unselected group of sick children are examined no significant variations are found. In the cases of institutionalized children, however, the defects may be in part the basis of a mental retardation. These children remain in a highly restricted environment for a long time, and their mental development is probably affected by their relative isolation.

Nutrition and Intelligence

Physicians have always considered the nutritional state of a child an important element which contributes to his general physical development. The nutritional condition is usually considered a criterion of a child's physical state and development. Psychologists have frequently reported that the intelligence of children and especially their performance was affected by their nutritional condition. Very few well-controlled and systematized studies have been made on the relationship between nutrition and mental growth. This is in part due to the difficulties of selecting an ordered series of criteria of nutritional develop-

¹⁶ S. Dawson and J. C. M. Conn, Intelligence and disease, *Special Report Series*, Medical Research Council (Great Britain), 1931, No. 162.

ment which may be correlated with measures of intelligence. There are at present no definite quantitative methods for the evaluation of the exact nutritional condition of an individual. Extremes can be recognized with some degree of certainty, but it is almost impossible to place any sampling of children in a rank order distribution on the basis of their nutritional states.

The literature contains only occasional reports of investigations on the relationship between nutrition and intelligence. In one of these studies, Hoefer and Hardy¹⁷ investigated 343 school children from the third and fourth grades. Physical examinations were made and the children were also given tests of hand-gripping strength. Some anthropometric measures were made, and weight-height indices were obtained. The children were given the Stanford-Binet and Stanford Achievement Tests, and were divided into four groups according to their physical condition. Hoefer and Hardy found that the children with a better physical condition tended to improve their intelligence and educational achievement scores more than the children with poor physical development. The differences were not sufficiently significant to be accepted as reliable. A report by Dowd¹⁸ showed that the distribution of the intelligence scores of malnourished children was quite similar to that of normal children. When the nutritional condition was improved, there was no substantial improvement of the I.Q.'s. Contrary evidence was reported by Poull.¹⁹ She studied 41 children who were definitely malnourished at the time of the first test and well nourished at the time of the retests. The results were compared with the test scores of a similar number of children who were at all times well nourished. The Kuhlmann-Binet and the Stanford-Binet tests were used. The results of the retests showed an average gain of 10 I.Q. points in the group which was originally malnourished and no gain in the other group. (There was a standard deviation of 12 I.Q. points in the mal-

¹⁷ C. Hoefer and M. C. Hardy, *The influence of improvement in physical condition on intelligence and educational achievement*, 1928, *27th Yearbook, Part I*, National Society for the Study of Education, pp. 371-387.

¹⁸ H. L. Dowd, *Relations of mental retardation to nutrition*, *Hospital Social Service*, 1922, 6, 92-95.

¹⁹ L. E. Poull, *The effective improvement in nutrition on the mental capacity*

of young children, *Child Development*, 1938, 9, 123-126.

nourished group, however, presumably because of the variability of the degree of malnourishment.) The critical ratio was 2.43. The results showed that the older the child the less gain he makes as the result of an improved nutritional condition. Poull also stated that an average of eighteen to twenty-four months is required to cause a significant gain. Poull's conclusions must be evaluated in terms of the small number of cases, especially in given age groups. Another study in which the investigators attempted to prove the direct effect of nutrition upon intelligence was reported by Graper and Park.²⁰ This study is inconclusive because only eight undernourished mentally-backward children were examined. The authors were fairly certain, however, that improved feeding resulted in improved mental ability.

TABLE 2
I.Q. CHANGE BY AGE
(According to Poull)

Age	Group I— Malnourished		Group II— Well Nourished		Difference
	No. of Cases	Average I.Q. Change	No. of Cases	Average I.Q. Change	
2	11	+13.0	5	+2.4	+10.6
3	15	+14.4	7	-2.85	+17.25
4	8	+ 5.3	10	-1.8	+ 7.1
5	0	.....	8	+1.6	.....
6	5	+ 1.6	9	-0.77	+ 2.37
7	2	+ .5	2	+1	-.5

It is probable that extreme malnutrition does cause physiological changes and reduced reactivity which may have an effect upon the results on intelligence tests. The thesis may also be accepted that malnourishment which reaches a pathological state results in biological changes which affect the total behavior of an individual. This does not mean that the differences in nutri-

²⁰ F. M. Graper and E. W. Park, The effect of improved feeding on the physical and mental development of undernourished and backward children, *Journal of Home Economics*, 1923, 15, 627-632.

tion inherent in a normal distribution correlate with a normal distribution of intelligence. There have been some indications from several studies that the irritability which results from a slight degree of malnutrition or fatigue may have a stimulating effect upon performance on an intelligence test. This is not to say, however, that malnutrition and fatigue increase basic intelligence. It may be, however, that the alertness necessary for good performance on a test may be stimulated by fatigue although severe fatigue obviously hinders performance.

Endocrine Disorders

Probably because no direct relationship had been found between ordinary measures of physical development and intelligence, attention was turned to the study of endocrine functions as a possible factor in the determination of intellectual growth. Studies have been made on the endocrine functions of normal and mentally retarded children, and persons of varying degrees of mental retardation have been compared. The obvious difficulty of such studies is the lack of exact methods except in cases of thyroid disorders in which basal metabolic rates and blood examinations give accurate diagnostic clues. Marinus and Kimball²¹ made a study of children in the special classes of Detroit schools. The children examined were of the following classifications: clinical hypothyroidism, congenital hypothyroidism, congenital goiter, bilobar pituitary deficiency, and anterior lobe deficiency. No adequate diagnostic picture could be obtained, however, for pineal, thymus, gonadal, or adrenal cortex dysfunctions. Of 3,585 children examined, 18.6 per cent showed evidence of an endocrine disturbance. Two-thirds were hypothyroids and one-third had some form of pituitary disturbance. In the cases of the pituitary deficient, the adjustment of the children was the same for the treated and untreated cases. Rothbart and Haw²² studied 98 children with I.Q.'s ranging from

²¹ C. J. Marinus and O. P. Kimball, Endocrine dysfunctions in retarded children and their response to treatment, *Endocrinology*, 1930, 14, 309-318.

²² H. B. Rothbart and A. B. Haw, Basal metabolism in children of normal and of subnormal intelligence with blood cholesterol and creatinine values, *American Journal of Diseases of Children*, 1935, 49, 672-688.

60 to 120. They found no definite relationship between the mental status and the basal metabolic rates of the children. They also found no essential differences in the blood cholesterol values between children of normal and those of subnormal mentality.

Somewhat contradictory results were obtained by Hinton,²³ who studied 90 children, five to fifteen years old. They were examined physically to rule out all extraneous conditions and were then given basal metabolic rate tests and Stanford-Binet or Arthur Point Scale tests. The coefficient of correlation of the basal metabolic rate with the Binet was $.736 \pm .032$, and with the Arthur, $.661 \pm .040$. This might indicate a causal relationship, but the data show considerable spreading and overlapping. The question arises as to whether these 90 subjects represented a normal distribution. Apparently they did not, and the high coefficients cannot be considered as evidence of a parallel relationship between normal basal metabolic rate and normal intelligence.²⁴

When definite endocrine disturbances are observed in children, one may expect to find a large number of mental retardations and deficiencies. This is not because there is a definite causal relationship between the degree of endocrine functional adequacy and the degree of mental development but rather because a serious endocrine disturbance affects general growth as well as intelligence. A number of studies have shown that nearly all cretins and most children with hypothyroidism are either mentally defective or seriously retarded.²⁵ In addition to their deficiency on tests of intelligence, they are mentally much slower than would be expected by their I.Q. level. Obviously, the achievements of these children are affected not only by their lack of adequate intelligence but also by concomitant physical deficiencies.

²³ R. T. Hinton, Jr., The role of the basal metabolic rate in the intelligence of ninety grade school students, *Journal of Educational Psychology*, 1936, 27, 546-550.

²⁴ See O. P. Kimball and J. C. Marinus, The relation of endemic goiter to mental deficiency, *Annals of Internal Medicine*, 1931, 4, 569-577.

²⁵ See A. Lewis, N. Samuel, and J. Galloway, A study of cretinism in London with especial reference to mental development and problems of growth, *Lancet*, 1937, 1, 1505-1509; 2, 5-9.

Neurological Defects

It might be expected that neurological defects would show a very close relationship to mental deficiency. Studies have shown, however, that only given types of cerebral lesions have a permanent effect upon mental development. Studies of mentally deficient children have shown that cerebral lesions are more frequent than in normal children. The reported high frequency is probably due in part to the peculiar selection of the children, especially those who were institutionalized. A large number of mentally defective children may have cerebral lesions which are not easily diagnosed. For example, the frequency of muscular incoordination among mental defectives is much greater than among normal children, and this may indicate some central nervous system dysfunction. It is somewhat difficult to differentiate between muscular incoordination which manifests itself in defective manipulatory reactions which are due to central lesions and those which are concomitants of a mental retardation. A number of studies have indicated that the sensorimotor defects of mentally deficient children may be the result of central nervous system disturbances. An example of such findings is seen in the investigation of Gordon and Norman.²⁶ They studied 336 unselected institutional cases of mental defectives and found that abnormal neurological signs were more frequent in the lower grade mental defectives. They implied that the poor coordination and other muscular disturbances may not be due to definitive cerebral lesions, but rather to poor cerebral control.

A good example of poor cerebral control was observed in a twelve-year-old girl who showed no neurological defects except the incoordination of her hands. She was born at full term and was considered normal by the obstetrician and pediatrician. Her development was considered normal until the parents noticed that she was late in walking and when she did walk at the age of two she showed a lack of coordination. She was first

²⁶ R. G. Gordon and R. M. Norman, Further observations on neurological abnormalities in mental defectives, *Journal of Neurology and Psychiatry*, 1938, 1, 173-179.

enrolled in a kindergarten at the age of five, but she failed to adjust well. She was stubborn, her attention span was short, and she rebelled against directions.

She was observed during a period of six months. She showed the usual signs of a serious mental retardation which was aggravated by her incoordination. Her handwriting was poor and she was unable to learn the simplest manual tasks because of her inability to use her hands well. An attempt was made to teach her sewing and weaving, but because she took such a long time to finish even the most simple tasks she lost interest and refused to go on with her work. Her parents had attempted to teach her to skate since she was six, but only when she was thirteen was she able to succeed without fear and frequent falls. On the basis of intelligence tests she showed an I.Q. of 70. To the casual acquaintance, however, she gave an impression of having a higher intelligence because of her good verbal ability. She was socially well trained and she had many graces which pleased her friends. The superior verbal ability was illustrated by the fact that on the Chicago Non-Verbal Test and the Arthur Point Scale her I.Q. was 54. The physical examination was essentially negative. The reflexes were somewhat hyperactive but not pathological.

The question frequently arises as to the effect of general cerebral disturbances upon intellectual development. Obviously any disturbance which causes physical incapacity has either a direct or an indirect effect upon intellectual development. A child who is unable to make use of his environment and who is not able to respond to ordinary stimuli is handicapped in the learning process. Hence, his mental growth shows a deceleration early in childhood and results in a permanent retardation. There is a practical question of whether intellectual development is affected by the general consequences of the condition of the nervous system or by the direct effect of the nervous lesions. Lord²⁷ made a study of 35 cases of bilateral dyskinesia of cerebral origin. These included cases of spastics, athetoid and motor retardations, infantile cerebral palsy, Little's disease, and

²⁷ E. E. Lord, A study of the mental development of children with lesion in the central nervous system, *Genetic Psychology Monographs*, 1930, 7, 365-486.

cerebral spastic diplegias. Miss Lord believed there was no proof, as a result of her study, that loss of motor efficiency in a given situation destroys an appreciation of that situation. In any individual case the site of a neurological lesion is not predictive of the mentality which the child will develop. Thus, she believed that mental appreciation can develop independent of motor control. Sixteen of the children showed a mental status equal to their chronological age, and the other nineteen were mentally defective. Some children with dyskinesia involving the speech mechanism seemed to be mentally superior. A number of investigators are of the opinion, however, that even minor cerebral lesions may have a distinct effect upon intellectual development. Doll,²⁸ for instance, stated that neuromuscular defects of speech were present in practically all of his mentally subnormal subjects at Vineland. Many of the cerebral lesions occurring at birth may frequently be overlooked. Doll stated that mental subnormality is about 20 times more frequent among the birth-injured children than among the physically normal. The intelligence of the birth-injured ranges from idiocy to the superior adult levels. The importance of Doll's work on the frequency of birth injuries is enhanced by the current knowledge that the severity of motor impairment is not a good index of the degree of cortical damage. This is significant in view of the fact that, in the past, diagnoses of birth injuries were made mainly in terms of the severity of motor defects.

Sensory Defects

The environmental influence upon intelligence has been pointed out by a large number of observers. Whatever one's theory may be regarding the origin of intelligence and the nature of its development, there can be no doubt of the important influence of the environment. In evaluating the effect of the environment, the sensory reactability of the individual must also be considered. A child with a defective sensory apparatus cannot be expected to profit by his environment, no matter how

²⁸ E. A. Doll, Psychological significance of cerebral birth lesions, *American Journal of Psychology*, 1933, 45, 444-452.

stimulating and effective it may be to the normal child. This is especially true of children with defects of the higher senses, notably vision and hearing. Minor disturbances of vision or hearing have not been shown to be important causative influences in cases of mental retardation or deficiency, although a number of investigators have emphasized the role of deafness and blindness, relative or absolute, in the production of mental defect. The scattered investigations in which correlation studies have been attempted on the relationship between the degree of hearing or visual acuity and the level of intelligence have not been conclusive. This is partly due to the investigators' inability to equate exactly the various influences of the environment. Most of the studies have been confined to deaf or blind pupils in either public or special schools. In a study by MacKane,²⁹ 130 subjects ten to twelve years old were examined. They were deaf pupils in a public school and in a residential school. They were given a battery of tests selected from three performance scales, and the same tests were administered to a control group of subjects. In addition to these tests, the Pintner Non-Language Mental Test was also given. Of the various scales the Drever-Collins showed that at no age level were the deaf children retarded as much as one year. The Grace Arthur Performance Scale showed that the children with good hearing surpassed the deaf children. The Pintner-Paterson scale also showed the same results. In general, it may be assumed from this study that even when all factors are equated, such as age, physical development, and environment, the children without a hearing defect surpass those who are deaf or even partly deaf. Similar results were obtained by Madden,³⁰ who examined hard-of-hearing children, that is, those with defective hearing who did not need a mechanical aid. Forty-six children were compared with children of normal hearing. On the Stanford-Binet the difference between the two groups was 6.42 points. The conclusion was reached that an increased amount of auditory

²⁹ K. MacKane, A comparison of the intelligence of deaf and hearing children, *Teachers College Contributions to Education*, No. 585, 1933, New York, Teachers College, Columbia University.

³⁰ R. Madden, The school status of the hard of hearing child, *Teachers College Contributions to Education*, No. 499, 1931, New York, Teachers College, Columbia University.

loss has no relationship to greater differences of intelligence. The achievement difference between the hard-of-hearing and those of normal hearing was negligible when the I.Q. was held constant.

General Physical Characteristics of Mentally Deficient Children

In the past there was a great deal of discussion regarding the importance of the so-called stigmata of mental deficiency. Various observers have pointed out the frequency of physical defects in mentally deficient individuals. Among modern writers Tredgold emphasized strongly the importance of these stigmata. In the early part of this century and in the latter part of the last century, physical signs were considered to be an important basis of a diagnosis of mental deficiency, and many writers vied with each other in their descriptions of *stigmata of degeneracy*. The stigmata which were described were of various kinds, such as skeletal abnormalities, skin changes, malformations of the head, eyes, and ears, and asymmetrical growth of the trunk or limbs. At one time each stigma or defect was considered to be individually important and when a subject showed a number of such defects the prognosis was accordingly considered more serious. In recent years, however, most studies have shown that the "stigmata" are not definitive but are the result of a general defect of physical development. When localized physical defects occur in normal persons, they are generally overlooked. The general nature of these defects rather than their isolated specific significance is illustrated in the results of investigations like those of Burke,³¹ who studied 3,000 mentally deficient patients. He concluded that the physical anomalies and defects of the mentally deficient individual are generalized rather than localized. He emphasized especially such defects as cleft palate, harelip, ear malformation, tooth defect, and extreme deviations, such as webbed toes or fingers and asymmetries. Myerson³²

³¹ N. H. M. Burke, Stigmata of degeneration in relation to mental deficiency, *Proceedings of the Royal Society of Medicine*, 1931, 24, 413-428.
³² A. Myerson, The pathological and biological bases of mental deficiency, *Proceedings of the American Association for the Study of the Feeble-minded*, 1930, 54, 203-226.

also emphasized the importance of considering the person with a mental defect as generally defective and therefore tending to have one or more external, observable physical anomalies. He pointed to the frequency of skeletal growth defects, sensory defects, the presence of organic brain disease, and a number of visceral abnormalities. Skeletal anomalies are also much more frequent in mentally defective than in normal children. Examinations by X-ray have shown that mental defectives frequently have extra epiphyses and an unusual number of sesamoid bones. In some cases these malformations may be due to asymmetrical development and in other cases to endocrine disturbances or nutritional disorders. Accelerated or delayed ossification of various bones have been found in mentally retarded individuals. This is at times due to endocrine disorders which are not always accurately measurable with the available techniques. As a corollary to these findings, it has also been discovered that abnormal growth, such as acromegalic gigantism, and lack of normal growth as in some types of dwarfism, both due to pituitary disorders, are closely associated with mental deficiency.

The unwary investigator is sometimes tempted to conclude from the evidence of the frequency of physical disturbances and disorders in mentally deficient children that mental and physical defects are causally related. A variety of factors may cause physical aberrations in defective children, but these aberrations are neither the result nor, at all times, the cause of the lack of adequate mental growth. As an example, mentally deficient children are likely to have many illnesses. Anatomists have shown that the frequency of illness, and especially of the childhood infectious diseases, is directly related to the frequency of growth distortions. The socio-economic level from which these mental defectives come must also be taken into account. Children of families of lower socio-economic levels usually live in poor hygienic conditions. They are also likely to suffer from nutritional lacks and in many cases from nutritional disorders. The frequency of accidents is also high in defective children. Abnormal labor is also more frequent in the cases of defective children, and this has been considered an important factor, not

only as a cause of brain injury but also as a cause of general physiological injury.³³

From the standpoint of causation of mental deficiency, a number of physicians have emphasized the role of common physical defects and disturbances. As an example, the condition of the tonsils and adenoids has at times been considered as an etiological factor in cases of mental retardation. At one time physicians tended to recommend the removal of tonsils and adenoids from feeble-minded and retarded children on the assumption that the removal of diseased tissues would facilitate mental growth. Clinical evidence has shown, however, that although the performance on intelligence tests may be affected by minor physical disturbances, such as diseased tonsils, the results are not encouraging.

It seems logical that intelligence should be affected by the presence of a debilitating disease. The accompanying fatigue and the lack of energy seriously impair the performance on tasks by which intelligence is measured. The question obviously arises regarding the nature of the performance defect. Does it signify a real impairment of intelligence, or does the basic capacity remain unchanged? The reports of studies which have been published in medical and psychological journals have usually claimed that chronic and debilitating systemic diseases affect intelligence and that the younger the child at the time of the onset of the disease the greater the mental retardation. Hookworm infection has been reported as having a serious deleterious effect on mental development. Those sections of the country in which there is a high rate of hookworm also show a high rate of mental retardation and deficiency. Children who are infected with hookworm show a lower I.Q. than those who are free from infection. One precaution must be taken, however, before definite conclusions can be made from these findings. Those sections of the country in which a high rate of hookworm exists also have inadequate hygienic, social, and educational facilities. It may be inferred, therefore, that at least some of

³³ N. A. Dayton, Abnormal labor as an etiological factor in mental deficiency and other associated conditions, *New England Journal of Medicine*, 1930, 203, 398-413.

the cases of mental retardation are due to factors other than the hookworm.

Children with malaria have also been compared with malaria-free children, but no significant differences have been found. Children who are bedridden as a result of tuberculosis usually show a lower I.Q. than normal children, but conclusions cannot be made regarding the direct effect of the disease. Such children are definitely ill, and the test results are not valid, in large part because they have little opportunity to gather the information and develop the skills demanded by an intelligence test.

In summarizing the evidence of the relationship between physical disturbances and mental retardation, it is clear that minor physical defects have very little influence upon mental growth. Mental retardation caused by central nervous system disturbances may be accompanied by sensory and motor defects. Debilitating diseases which remove a child for a long period from ordinary social contacts may affect the rate of his intellectual growth.

There are no specific stigmata of mental deficiency. Physical defects and abnormalities are, however, more frequent in the mentally deficient child than in the normal child. These defects are not diagnostic signs of mental deficiency but, as Myerson and others have pointed out, are indicative of a general biological deficiency. The rate of physical growth of the normal child is on the whole greater than that of the mentally defective child, but no high correlation exists between the adequacy of physical development and the adequacy of mental development.

Chapter 4

ENVIRONMENT AND INTELLIGENCE

Environment and Performance

In the chapter on mental growth, reference was made to the controversies regarding the constancy of intellectual growth. Obviously it would be impossible to speak of innate capacity unless it were also assumed that intellectual growth is constant, except for special circumstances which interfere with this growth. If the theory of innate capacity is accepted, it must also be assumed that environmental conditions, no matter how favorable, cannot increase innate capacity but can only allow its complete development.

The very nature of the mental tests which are used to measure innate capacity increases the difficulty of determining the influence of the environment. Tests are indirect measures of intelligence, that is, the amount of innate capacity is inferred from the level of achievement which a child shows on intelligence tests. In general, it is assumed that the differences in the environments of the majority of children are negligible in their effect upon intellectual development. Thus, it is also assumed that only large environmental differences can affect the way in which the capacity of an individual develops and manifests itself in achievement.

In recent years the assumption that innate capacity can be measured at various periods during childhood has been criticized by a number of investigators. They have pointed out that even minor differences in the environmental backgrounds of a child may seriously affect his performance, and, because capacity is inferred from performance, erroneous interpretations may be made.

In 1925 Bagley stated:

On the basis of tests which admittedly measure the influence of experience—he [the determinist] argues back to a hypothetical factor which, far from having isolated, he has never clearly defined. . . . He then, by an act of pure imagination, reads out of the product everything that experience, education, and training have contributed. . . . Only recently he has been confronted with the conclusion, based upon the statistical methods which he himself has employed, that not less than 54 per cent of whatever it is that is measured as native intelligence turns out to be the result of experience and training. . . . He concludes that it [intelligence] can never be modified by the experiences which he has assumed that it has acted upon—and the products of which constitute his only measure for the thing itself. He is convinced that it grows . . . from birth to a very definite point which varies among individuals, but which, for most people, is fairly early in life, at which point, like anatomical structures, it "stops short—never to grow again." This point, which seems to be purely hypothetical, has jumped back and forth over the chronological ages between 13 and 18, like a veritable grasshopper, displacing by several degrees at each jump, the I.Q.'s of all individuals who have passed the age in question. . . .¹

Most psychologists have not overlooked the influence of environment and experience. The universal acceptance of the necessity to obtain a fair sampling of the population in measuring intelligence and in validating a standard test indicates that psychologists have recognized the influence of the environment. In general, however, minor environmental differences have been overlooked in the standardization of tests in spite of recent findings that even a minor environmental handicap may affect test performance. As an example, an environmental situation which causes a language handicap may result in a poor test performance. A child who does not understand the meaning of a given question either because he does not understand the symbols of the language or because the implications of the question have not been within his experience, cannot perform at the level expected of him. Many cultural and environmental differences exist, and although they are not extreme they may, nevertheless,

¹ W. C. Bagley, Determinism in education, 1925, Baltimore, Warwick & York, Inc., pp. 18-19.

less, affect language usage and understanding. Consider, for example, one of the simplest problems of a standard test of intelligence. Suppose a child is asked what he would do if he were on his way to school and believed that he would be late. The usual answer is that he would run quickly or perhaps ride on a streetcar or taxi. Suppose, however, that a child has always ridden to school in an automobile. Or, as a better example, suppose the child has only rarely attended school, and his culture does not demand regular school attendance. In a study of mountaineer children it was discovered that many children failed on this question. They were not accustomed to going to school, and at any rate never considered tardiness of great importance. Some of the children stated that they would just be late, others said that the teacher might scold them, and still others failed to understand the significance of the question. Although it might be unfair to compare the responses of mountaineer children with those living in an ordinary urban environment, the example nevertheless gives rise to the question as to whether even minor differences in environmental and cultural backgrounds might not affect the performance on a test which involves an understanding of language symbols. The language expressions which a child uses may be another factor which determines the score he obtains on a given test.

Not only is the actual performance affected by a language handicap, but intellectual growth itself may also be hindered. Intellectual growth manifests itself by the accumulation of increments, that is, various abilities accrue in a cumulative manner and enable the individual to perform at an increasingly higher level. A language defect necessarily involves a defect in symbolic adjustments, and thus tends to retard the sequential development and the combination of increments. For all practical purposes, therefore, a language handicap may affect innate capacity in terms of retarding its outward manifestations. Even though a language handicap may exist only up to the age of six or seven, a sufficient handicap to the growth of intelligence may have already occurred to retard the child permanently.

The importance of early handicaps has been shown in a number of studies. A child who must learn a new language at

the age of twelve is not as seriously affected as a child of six, in spite of the greater rapidity with which the younger child frequently readjusts to a different language. The twelve-year-old, for example, has already attained a large part of his growth and a temporary handicap may therefore not seriously affect the subsequent growth. A child of six, on the other hand, whose mental growth does not proceed at the level of his capacity may permanently suffer even from a temporary handicap.

As we have seen in Chapter 1, intelligence is composed of many factors. When intelligence is measured and a person is defined in terms of a score or a mental age, it does not mean that a single unit characteristic has been measured. It is also probable that intelligence is composed of many different items and functions which develop at different rates. Consequently, errors in measurement are likely to result when any of these items or functions is altered by peculiar environmental conditions which may not be recognized otherwise. Thus, a sensorimotor handicap which appears to be minor from the standpoint of the total adjustive mechanism may nevertheless be a significant factor in altering the score on a test.

The effect of a consistent environment upon the intelligence of a child has been illustrated in a number of ways. For example, the correlation between the scores on intelligence tests and the educational and occupational status of the mother and father increases with age for the first seven or eight years. This may indicate either that the environment has a definite effect upon the rate of mental growth or that tests given at an early age do not have a high predictive value. Although it cannot be denied that the nature of the environment may to some degree determine the scores on tests, especially because most tests involve a knowledge of information and language, the most important factor in the increasingly significant correlation is the unpredictability of tests given during early infancy. By the application of the criterion of tetrad differences, Slocombe² attempted to show that there is a factor common to early tests

² C. S. Slocombe, Why the I.Q. is not and cannot be constant, *Journal of Educational Psychology*, 1927, 18, 421-423.

and retests and another factor common to late tests and retests. He found, however, much lower coefficients of correlation between early tests and later retests. As a result of his evaluations, Slocombe concluded that comparisons of scores at different ages are invalidated by the fact that the same capacities or performances are not measured at different ages. Pintner³ also pointed out that age influences the results on intelligence tests and the changes in I.Q. He classified the factors which affect changes in I.Q.'s as intrinsic and extrinsic. The intrinsic are those due to the developmental processes of the child, and the extrinsic, those due to the problems of the test itself and the variety of environmental influences which affect performance.

Rural and Urban Environments

Most investigators have found a significant difference between the intelligence scores of children living in rural areas and those living in urban centers. It was formerly believed that this difference is due to selective migration from country to city. Pintner, for example, believed that the factor of selective migration to the cities of persons of superior intelligence accounts for this difference. Estabrook⁴ believed that the energetic individual does not remain in an area which does not afford him adequate opportunity for development. The implication is that the more intelligent individual is more energetic and thus is more likely to move to an environment allowing him a greater opportunity. The findings on carefully sampled populations contradict the inferential evidence which has been employed to show that the more intelligent migrate to larger cities. Studies of Negroes have shown that those who live in cities attain higher intelligence ratings than those who have just migrated from rural areas. If migration is due to a selective factor, then the length of time which a person spends in a city should not be an important factor in making for differences in intelligence scores. Klineberg,⁵ in evaluating the problem of the relative importance of the racial heredity of Negroes and

¹ ³ R. Pintner, *Intelligence testing* (sec. ed.), 1931, New York, Henry Holt & Co.

⁴ A. H. Estabrook, *Blood seeks environment*, *Eugenical News*, 1926, 11, 106-114.

⁵ O. Klineberg, *Race differences*, 1935, New York, Harper & Bros.

their environmental backgrounds, showed that the nature of the environment affected their intelligence scores.

TABLE 3
BINET I.Q. AND LENGTH OF NEW YORK RESIDENCE
(Klineberg)

Group	Number of Cases	Average I.Q.
Less than one year.....	42	81.4
One-two years	40	84.2
Two-three years	40	84.5
Three-four years	46	88.5
More than four years.....	47	87.4
New York-born	99	87.3

A sample of Negroes who lived in New York less than one year showed an average I.Q. of 81.4, and those who lived in New York for four years or more, an average I.Q. of 87.4. It is possible, of course, that in given areas the migratory element may be an important factor in decreasing the average of the group. This was the implication of the study made by Hirsch.⁶ He studied the intelligence of east Kentucky mountaineer children in order to determine the relative influences of heredity and environment upon their intellectual development. He examined about 2,000 children from three different counties and made comparisons of different chronological groups and of children who had relatively good and relatively poor educational and social backgrounds. He found that the average I.Q. was 79. He assumed that if the I.Q.'s of the various age groups decreased markedly with an increase in chronological ages, the low I.Q.'s were due to environmental conditions. If the I.Q.'s increased, this might be due to the educational opportunities which the older children had. If the I.Q.'s remained relatively constant, however, the intelligence of the children could be considered due to inherent factors independent of the educational and social environments. He found that the I.Q. range was only

⁶ N. D. M. Hirsch, An experimental study of the east Kentucky mountaineers, *Genetic Psychology Monographs*, 1928, 3, 183-244.

12 points for the various age groups, and thus he concluded that the mountaineer children were inherently retarded. There was relatively very little difference between those children who lived in a very poor environment with poor educational facilities and those who attended an excellent school maintained by outsiders. The higher I.Q.'s which Hirsch obtained on children in the seventh and eighth grades were explained on the basis of the influence of education rather than on the basis of innate capacity. He found that there was a decrease of I.Q. with an increase in chronological age, but he believed that this decline was due to environmental factors. He concluded that the close inbreeding, especially in conjunction with selective migration, accounted for the lower general intelligence. The poor economic and social environment was considered by Hirsch only a minor causative factor and perhaps was the effect of inherent lack of energy, intelligence, and initiative. The more intelligent and more energetic persons migrated from these communities, and the ordinary mountaineers remained.

A careful evaluation of the data presented by Hirsch does not clearly substantiate the conclusions he made. It is highly improbable that migrations are due only to the factor of intelligence. It is well known that many other factors operate in causing people to migrate from one area to another, and intelligence is only a minor factor. Furthermore, if, as Hirsch has shown, the I.Q.'s decrease with age, the conclusion that this is not due to the environment cannot be accepted.

It is probably fair to assume that the stimulation of an environment has an important influence upon the rate of intellectual growth. It may also be assumed, tentatively perhaps, that the degree to which intelligence develops, at least as measured by tests, is determined by the requirements of an environment. If normal adjustment to a given environment does not require an intellectual development beyond the mental age of, say, eleven, there is no psychological reason for further development of intelligence. This was one of the implications of a study by Sherman and Key.⁷ An investigation was made of

⁷ M. Sherman and C. B. Key, Intelligence of isolated mountain children, *Child Development*, 1932, 3, 279-290.

children living in four hollows in the Blue Ridge Mountains. In the most isolated of these hollows there were very few environmental opportunities for the children. The families lived in scattered log huts. There was no road to the outside world except trails which could be used only for walking or horseback. There was no place for community meetings or any regular church services. Nearly all the adults were illiterate. They were descendants of families who settled most of the mountain areas during the Colonial period. The second hollow was somewhat better organized socially. The agricultural habits of the people were definitely patterned, and there was a greater amount of schooling. The people of this hollow frequently visited a village at the foot of the mountains, and the men were often employed in the valley during apple-picking time. Small meetings, informal and to a large degree purposeless, were held in this hollow. The third hollow was on a still higher level. The children attended school for four months each year. The inhabitants at times had some surplus farm products which they sold in the valley. The fourth hollow was organized somewhat like the usual "crossroads" hamlet. A school had been established there by missionaries, and the state had conducted school regularly for the past nine years. The farms were larger than those of the other hollows, and there nearly always was a surplus of farm products which was regularly sold to outsiders. The school term was about seven months each year for the past eight years, and about 75 per cent of the inhabitants were literate.

A battery of tests was used consisting of the Stanford-Binet, the National Intelligence Test, Scale B, Form 2, the Pintner-Cunningham Primary Mental Test, and four performance tests—the Mannikin-Seguin Form Board, the Healy-Fernald Puzzle A, the Knox Cube Test from the Pintner-Paterson Scale of Performance Tests, and Goodenough's Drawing of a Man. For the children of all the hollows the average I.Q. on the Stanford-Binet was 62; on the National, 61; the Pintner-Cunningham, 76; the four performance tests, each scale, 84; and Goodenough's Drawing of a Man, 72. When the children

were compared according to increasing chronological age, it was found that as their ages increased, their I.Q.'s decreased. For example, on the performance scale the average I.Q. for children six to eight years old was 91; for years eight to ten, 84; for years ten to twelve, 86; for years twelve to fourteen, 83; for years fourteen to sixteen, 75. The performance on the Drawing of a Man showed a decrease in I.Q. from 80 at ages six to eight, to 49 at ages fourteen to sixteen. A similar decrease in I.Q.'s was seen in the scores on the Stanford-Binet. This decrease does not mean a deterioration of intelligence. It does mean a deceleration. The implications are evident. It is probable that the requirements of the environments represented in these mountain hollows did not facilitate the development of intelligence in the normally expected manner. The young children more nearly approximated the average of other communities, whereas the older children were retarded. The degree of deceleration also paralleled in a rough way the general social level of the communities in which the children lived. For example, on the Stanford-Binet, 84 per cent of the children in the hollow of lowest socio-economic level were retarded; 64 per cent were retarded in the next hollow; and the other two hollows showed retardations of 50 and 25 per cent. It may therefore be concluded that intelligence as measured by standardized tests depends to a large degree upon the opportunities which the environment affords and upon the requirements made upon the individual. The degree of motivation was an important contributing factor in the determination of the level to which the measurable intelligence developed. The effect of motives and incentives upon learning and upon I.Q. has been pointed out by other investigators. Hurlock,⁸ for example, showed that incentives in the experimental situation were also of importance. She showed that incentives in the form of praise and reproof raised the average I.Q. as much as seven points, whereas a control group of children showed an increase of less than one point.

⁸ E. B. Hurlock, The effect of incentives upon the constancy of the I.Q., *Journal of Genetic Psychology*, 1925, 32, 422-434.

Effect of Environmental Changes

The greatest difficulty encountered in the studies of environmental effects is due to the lack of exact quantitative measures of environmental differences. Extremes of environment can be described fairly accurately, but small and nevertheless important differences can neither be described nor accurately measured. In the study of mountain children, previously cited, an attempt was made to describe the levels of each of the communities in terms of the environmental conditions which facilitated group activity and social interchange. Examples of the criteria were the number of newspapers and of books, the number of bank accounts in the community, the number of radios, the number and condition of the roads, and the frequency of group meetings. The intellectual level and the education of the parents were also considered important factors. In general, the economic level and the education of parents are two of the most important criteria employed in the determination of the effectiveness of an environment in stimulating a child. One of the most important studies in this field was made by Freeman⁹ and his associates. They studied the intellectual development of children placed in foster homes of varying socio-economic levels. They tested children before placement and retested them later in their foster homes. The children who were placed in the better homes gained on the average of 5.3 I.Q. points, whereas those in the poorer homes gained on the average of only .1 point. They also found that when young children were placed in good foster homes they increased their I.Q.'s to a much greater degree than older children. The correlation between the intelligence of separated siblings was lower than for the siblings reared together. This implies that the high degree of resemblance between siblings is to a large degree due to the influence of the same environment. In some cases the true parents of these children were defective, but there was no direct relationship between the intelligence levels of the true parents and the

⁹ F. N. Freeman, K. J. Holzinger, and B. C. Mitchell, *The influence of environment on the intelligence, school achievement, and conduct of foster children, 1928, 27th Yearbook, Part I, National Society for the Study of Education*, pp. 101-217.

I.Q.'s of their children who were placed in foster homes. Barbara Burks¹⁰ made a similar study upon foster children. She found that home environment contributed about 17 per cent of the variance of I.Q. Measurable environment one standard deviation above or below the mean of the population ordinarily does not shift the I.Q. by more than 6 to 9 points above or below the value it would have under normal environmental conditions. The maximum contribution of the best home environment to intelligence was about 20 points. Burks pointed out, however, that, ordinarily, extreme variations in environment to which a child is exposed occur but rarely. Contrary to these findings, Rogers, Durling, and McBride¹¹ concluded that the results of their investigations showed no appreciable effect of environmental aid upon the I.Q.

Effect of School Training

An approximation of the experimental method was made in a number of studies on the effect of environment in changing the I.Q. This was made by comparing children of different school backgrounds. When all of the controlled factors are equated, it can be assumed that the amount of schooling and, in some cases, the kind of schooling determines whether a good educational environment affects the I.Q. One of the first of these studies was made by Woolley.¹² She compared the scores of children who had attended nursery school with those of the same age and social status who had not attended. The children were applicants for a nursery school, and the two groups were composed of those who were accepted and those who were rejected. Both groups were tested at approximately the same time. Retests were later made of both groups. Mrs. Woolley found that 63 per cent of those who attended the Merrill-Palmer School showed an increase in I.Q., the average being 19.7

¹⁰ B. S. Burks, *The relative influence of nature and nurture upon mental development*, 1928, *27th Yearbook*, Part I, National Society for the Study of Education, pp. 219-316.

¹¹ A. L. Rogers, D. Durling, and K. McBride, *The effect on the intelligence quotient of change from a poor to a good environment*, 1928, *27th Yearbook*, Part I, National Society for the Study of Education, pp. 323-331.

¹² H. T. Woolley, *The validity of standards of mental measurement in young childhood*, *School and Society*, 1925, 21, 476-482.

points. Approximately 18 per cent showed a decrease, and the I.Q.'s of approximately 18 per cent were constant. Of those who did not have nursery-school training, 33 per cent showed an increase, the average increase being 12.7 points; 36 per cent showed a decrease; and the I.Q.'s of 31 per cent were constant. A possible criticism of such results may be that the nursery schooling was a direct aid in furnishing the children information which enabled them to respond to the tests more adequately. In other words, the gain in I.Q. of the children with nursery-school education may have been due to their learning of given types of information which was an aid to them in making successes on intelligence tests.

Another study was made by Goodenough.¹³ She also used two groups: one which had no nursery-school experience and another which had one year of nursery-school training. Goodenough found that those who had attended a nursery school attained a slightly higher I.Q. than those who had no nursery-school experience, but the differences were too small to be considered significant. She found, however, that there was no tendency for those who had the nursery-school experience to have the highest I.Q. The largest range of individual differences was found in those children who had no nursery-school training. It is important, however, to evaluate the influence of the type of environment from which nursery-school children are recruited. Some investigators have shown that the higher the socio-economic level of the children the smaller the gain in I.Q. The assumption may be made that those children who come from a lower socio-economic level have not had a sufficiently stimulating environment to develop their highest capacity and therefore placement in a nursery school is likely to increase their I.Q.'s.

Goodenough's observation that individual variations occur less frequently in children who have had nursery-school training has been corroborated by other workers. The relative uniformity of the training in a nursery school tends to make the

¹³ F. Goodenough, A preliminary report on the effect of nursery-school training upon the intelligence test scores of young children, 1928, *27th Yearbook, Part I*, National Society for the Study of Education, pp. 361-369.

responses of the children fairly uniform. Data on the effect of other types of early educational training have also been obtained. One of these studies was made by Heilman.¹⁴ A group of 828 children, ages ten years, one month to ten years, ten months who had had kindergarten education was examined and compared with children who had had no kindergarten experience. The differences between the two groups were insignificant, however.

In spite of the findings of Beth Wellman and others, which indicated that important and persistent differences occur as the result of nursery-school experience, an examination of all the available data does not confirm the recent optimism about the persistent effect of nursery-school education. An important factor to be considered in such studies is that the child who has good nursery-school education is also likely to have a better general environment than the child who has no nursery-school experience and is also likely to receive better training thereafter. Thus, comparisons of ten-year-olds or twelve-year-olds who have had and who have not had nursery-school education cannot be evaluated only in terms of the effect of nursery-school experience. If it may be concluded that the training of one group was directly effective in increasing the I.Q., it cannot be inferred, however, that the school experience was the only important factor. Those children who had better schooling also undoubtedly had better social environments in spite of the fact that for all purposes the environments of the two groups of children were considered to be about equal.

One of the most interesting and unique studies on the effect of schooling was made by Skeels and his co-workers.¹⁵ These investigators studied children in an orphanage. The conditions in this orphanage were about the same as in others. The children were given little chance to have many experiences, living facilities were overcrowded, and they were all treated in about

¹⁴ J. D. Heilman, The relative influence upon educational achievement of some hereditary and environmental factors, 1928, 27th Yearbook, Part II, National Society for the Study of Education, pp. 35-65.

¹⁵ H. M. Skeels, R. Updegraff, B. L. Wellman, and H. M. Williams, A study of environmental stimulation, *University of Iowa Studies in Child Welfare*, 1938, Vol. XV, No. 4.

the same manner. The investigators were instrumental in forming a preschool within this institution. A group of children was allowed to attend this preschool and was later compared with those in the same orphanage who did not attend the school. Thus, an excellent control was obtained in terms of living conditions, age, and general environment as compared with the specific effects of school training. After three months, fifteen children who attended the school made a gain of 3.8 points in I.Q., whereas sixteen children who were used as controls gained only .8 point. After twenty months, decided differences were found in favor of the preschool children. It was also found, contrary to the findings of Goodenough on nursery-school children, that the longer these children attended the special school within the orphanage the higher was the gain in I.Q.

The question might naturally arise as to whether the initial gain of the children who attend the preschool might be lost later on. There has been a good deal of controversy regarding the value of nursery-school training even though some investigators found that such training does raise the I.Q., perhaps because the children are given an opportunity to become acquainted with the information necessary to make successes on intelligence tests. In regard to the value of the preschool, Skeels and his co-workers made the following statement:

Taken all in all, the preschool exerted a profound influence upon the children during the period of preschool enrollment and probably in a number of instances changed the whole tenor of their later lives. Some of the children were made placeable in foster homes who almost certainly otherwise would have been doomed to commitment to an institution for the feeble-minded or at best would have continued to reside in the orphanage.¹⁶

The effect of early placement upon the change in I.Q. has already been mentioned. Few valid experimental studies are available, however. The most recent of these studies was made by Skodak.¹⁷ She studied the mental development of children placed in foster homes. She also compared the mental develop-

¹⁶ Skeels *et al.*, p. 185.

¹⁷ M. Skodak, *Children in foster homes: a study of mental development*, *University of Iowa Studies in Child Welfare*, 1939, Vol. XVI, No. 1.

ment of these children with their true and foster parents. Two groups of children from inferior families were studied: those who were placed when they were younger than six months old, and those who were placed in foster homes between the ages of two and five. The Kuhlmann and Stanford-Binet tests were used. It was found that the mental level which a child attained was closely related to the type of home in which he was reared and less closely related to the characteristics of his true parents. Skodak also corroborated previous findings that children placed in early infancy developed to a greater extent than those who were placed when they were older.

The importance of the studies by Skeels and by Skodak cannot be overestimated. The difficulty of a clear interpretation is obvious, however. Although all psychologists recognize that environmental changes produce changes in the scores on intelligence tests, no one has made an exact quantitative evaluation to determine the effect of specific factors involved in these environmental conditions. We know, for example, that the resemblance between parents and children is fairly close. We also know that the resemblance between children placed in foster homes and their true parents becomes less close with increasing age. Studies of parent and child resemblance have consistently shown a high correlation. Pearson,¹⁸ in an early study, found a coefficient of correlation of .47 in intelligence between father and son. In 1910 he found a coefficient of correlation of .49, and in 1915 he published material to show that when the two parents are compared with their children, the coefficient of correlation increased to .7. The fact that the intellectual resemblance to their true parents decreases with foster placement corroborates the belief of many psychologists that the importance of heredity in the transmission of intelligence has probably been overestimated. This may also be true regarding the findings of the relationship between the socio-economic status of parents and the intelligence of their children. It has been found, for instance, that children of parents vocationally classified in professional groups show a higher I.Q. than children of parents who are salesmen

¹⁸ K. Pearson and A. Lee, On the laws of inheritance in man, *Biometrika*, 1903, 2, 357-462.

or have semi-skilled or unskilled vocations. It is most probable that the environmental opportunities aside from any hereditary factors are important factors in the subsequent higher I.Q.'s of the families of higher socio-economic levels. The relationship between siblings is also high. Pearson found a correlation of .52; Pintner, .33; and Thorndike, .60.

Studies of Twins

One of the most logical ways of studying the effect of environment is by an investigation of the development of twins. One of the earliest controlled studies, frequently mentioned in the literature, was made by Thorndike.¹⁹ He wanted to discover whether the relationship between twins is closer than between other children and also whether they develop differently with growth. Thorndike concluded as a result of his studies that there was no higher correlation between the achievement of twins in trained functions than in untrained mental functions. He also concluded that inheritance is the major cause of intellectual development because older twins show a smaller correlation than younger twins in regard to intellectual abilities. In spite of the greater physical and intellectual similarity of twins than of other siblings and even greater similarity of identical twins, the development of the individual members of twin groups depends to a great extent upon the environment. In Gesell and Thompson's study²⁰ of the effect of specific training upon the development of each of a pair of twins, the assumption was made that sensori-motor adequacy can be used as a measure of the growth of intelligence. In this study one of the measures of intellectual growth was the increasing ability of the child in such an activity as stair climbing and in manipulatory behavior. One of the twins was allowed to practice whereas the other was not given any practice. When retested the child who had had practice was greatly superior to the other child, but after the nonpracticed child was allowed to take part in the activities of

¹⁹ E. L. Thorndike, Measurement of twins, *Archives of Philosophy, Psychology, and Scientific Methods*, 1905, 1, 64.

²⁰ A. Gesell and H. Thompson, Learning and growth in identical infant twins, *Genetic Psychology Monographs*, 1929, 6, 1-124.

TABLE 4

SUMMARY OF CORRELATIONS ON INTELLECTUAL RESEMBLANCE BETWEEN PARENTS AND CHILDREN

Author	N	Parent-Child r	Members Selected	Test
Pearson, 1903 Woods, 1906	Large 50+	.47 .3007 ± .0472	Father and son Father, grandfather, and son or daughter	Physical measurements 10-step scale for intellec- tual and moral traits
Schuster and Elderton, 1907 . . .	... . . . .	.312 (av. of 5 r 's)	Father and son	Oxford records of aca- demic standing
Pearson, 1910	Large	.49 (mean of many)	Father and son	Family records
Pearson, 1915	Large	.707 (multiple R)	Children and two parents	11 subtests, Verbal and nonverbal
Willoughby, 1923	Large	.35	Children and average of both parents	Stanford-Binet
Jones, 1928	105 317 317	.693 ± .034 .508 ± .028 .548 ± .026	Mid-parent, mid-child Father and child Mother and child	Stanford-Binet
Freeman, 1928 . . . . .	... . . . .	.35 ± .11	Mid-parent and each child	Otis Group
Burks, 1928	100 100 105	.52 .45 ± .05 .46 ± .05	Mid-parent and child Father M.A. Mother M.A.	Stanford-Binet
Banker, 1928	83	.49 ± .05	Mid-parent and child	Binet Binet Binet
Orthit, M. C., 1933	51	.77 to .80 .40 to .68	Mid-parent, mid-child Single parent, single child	Students' ability index based on school marks Children 14 and 16 years

(Adapted from G. C. Schwesinger, Heredity and environment, Table 39, p. 236, New York, Macmillan Co., 1933)

which he had been deprived he quickly reached the level of the other twin. As stated previously, the criticism may be made that the activities which Gesell and Thompson observed are not true measures of intellectual growth. A more serious criticism might be that the child who was not allowed to practice nevertheless did actually have indirect practice. In other words, the nonpracticed child did use given muscle groups and did practice activities which were necessary for stair climbing. The report of McGraw²¹ on Johnny and Jimmy is unique in that it showed for the first time how systematized training rapidly increased performance. It is not conclusive, however, regarding the rela-

TABLE 5
CORRELATIONS FOR THREE GROUPS OF TWINS
(From Newman, Freeman, and Holzinger, p. 347)

Trait	Identical	Fraternal	Separated
Standing height .....	.981	.934	.969
Sitting height .....	.965	.901	.960
Weight .....	.973	.900	.886
Head length .....	.910	.691	.917
Head width .....	.908	.654	.880
Binet mental age.....	.922	.831	.637
Binet I.Q. ....	.910	.640	.670
Otis I.Q. ....	.922	.621	.727
Stanford Achievement .....	.955	.883	.507
Woodworth-Mathews .....	.562	.371	.583

tive effects of environment and of inherited capacity because the two children were not identical twins. The most recently published study in which the environmental factors were carefully evaluated was made by Newman, Freeman, and Holzinger.²² These investigators studied 50 pairs of identical twins and 50 pairs of nonidentical twins reared together and, in addition, studied in detail the psychological and physical characteristics of 19 pairs of identical twins who had been reared apart,

²¹ M. B. McGraw, *Growth: a study of Johnny and Jimmy*, 1935, New York, D. Appleton-Century Co., Inc.

²² H. H. Newman, F. N. Freeman, and K. J. Holzinger, *Twins: a study of heredity and environment*, 1937, Chicago, University of Chicago Press.

frequently in very different surroundings. They found that physical characteristics are least affected by the environment and that intelligence is definitely affected by the individual's social background. As might be expected, educational achievement and personality are directly affected by environmental changes. Identical twins reared in the same environment change less than fraternal twins. This might be expected, possibly because of given inheritable qualities. The investigators concluded that when fraternal twins are reared together 25 or 30 per cent of the variance in intelligence may be attributed to environmental influences. The following table is a summary of the correlations for the three groups of the twins.

Racial Differences

An evaluation of the racial differences of intelligence requires a careful differentiation between those factors which are essentially of racial origin and those which are environmental. It is relatively easy to confuse racial with national differences. Anthropologists have pointed out the difficulty of differentiating pure races, and mixtures have become so common that an investigator is rarely able to make samplings of different races without encountering many difficulties. As Lehman and Witty²³ have shown, an investigation of racial differences is extremely difficult because it is almost impossible to identify and select different racial groups and to eliminate the factors of environment. When selections have been made, experimenters have been unable to equate the factors of language difficulty, the influence of varying levels of socio-economic status, the factor of cultural habituation, and educational influences. Garth,²⁴ in summarizing the results of psychological tests, concluded that the differences which have been found are probably based upon differences of experience and environment rather than upon basic racial differences. Freeman,²⁵ among others, has empha-

²³ P. A. Witty and H. C. Lehman, Racial differences: the dogma of superiority, *Journal of Social Psychology*, 1930, 1, 394-418.

²⁴ T. R. Garth, The hypothesis of racial differences, *Journal of Social Philosophy*, 1937, 2, 224-231.

²⁵ F. S. Freeman, *Individual differences*, 1934, New York, Henry Holt & Co.

sized the difficulty of designating races and has shown that the difficulty of equating the various factors has interfered with the interpretation of the results. He pointed out that the results of many testing programs have shown that differences are appreciably greater when individuals are grouped according to environmental backgrounds than when grouped according to racial differences. It has also been shown that the range of scores within any one group is frequently larger than that between groups.

There have been many reports on the test scores of American Indian children. The majority of Indian children have made scores lower than those of white children. It has not been very easy, however, to equate the various factors in these studies. For example, Jamieson and Sandiford²⁶ found that Southern Ontario Indians have a considerable language handicap. The children were tested on the National Intelligence tests and showed a median I.Q. of about 80. They found that the more white blood these children had the higher were their scores. On the Pintner-Patterson Scale of Performance tests the children were only slightly inferior to white children. Hunter and Sommermier,²⁷ in an earlier study on 715 American Indians at the Haskell Indian Institute, believed that they found that the scores decreased with an increase in the amount of Indian blood. The cultural background of Indian children, as Fitzgerald and Ludeman²⁸ have shown, causes them to make frequent failures although their intelligence level is probably adequate for successes at given levels. What is logical for an urban child may be illogical for an Indian child living on the prairie. Porteus reported that it is difficult to score certain performance tests. Even the simplest performance tests, such as the Goodenough Drawing of a Man, cannot be evaluated accurately. In Porteus' experience with Australians he found that their drawings, though perhaps adequate for their own observations, were in-

²⁶ E. Jamieson and P. Sandiford, The mental capacity of Southern Ontario Indians, *Journal of Educational Psychology*, 1928, 19, 536-551.

²⁷ W. S. Hunter and E. Sommermier, The relation of degree of Indian blood to score on the Otis intelligence test, *Journal of Comparative Psychology*, 1922, 2, 257-277.

²⁸ J. A. Fitzgerald and W. W. Ludeman, The intelligence of Indian children, *Journal of Comparative Psychology*, 1926, 6, 319-328.

adequate when scored on the standards by which they were validated.²⁹

In regard to immigrant children it has been pointed out that the socio-economic level is frequently one of the most important factors in creating a poor test performance. In New York City, Italians usually attain relatively low scores on standard tests, in some cases lower than the Negroes. The Italians and Negroes in New York City are, however, in the lowest socio-economic levels. Since a definite relationship usually exists between intelligence and the socio-economic level, we can readily understand that Italian immigrant children and Negro children might be expected to cluster at the lower end of the scale.

The factors of language and culture have been partialled out in part by Pintner and Keller,³⁰ who studied children of English and foreign-speaking families by means of performance tests. On the Binet tests, the children of the English-speaking families had a median I.Q. of 99, and those of foreign-speaking, 89. On the Pintner performance scale, however, their scores were 109 and 103.

An evaluation of the literature shows that the conditions under which mental tests were given to various national and racial groups must have varied because of the variety of results which have been obtained. For instance, the intelligence quotients of Italians varied from 78 to 91, depending upon the kinds of tests used and upon the conditions under which the tests were administered. Many, if not most, of the investigations of racial differences have been made on Negro children and adults. Mention has already been made of some findings which showed that the scores which Negro children made in New York City correlated to some degree with the length of time that they lived there. In addition, it is extremely difficult to select fair samplings of Negroes whose racial purity can be established. Some of the problems involved in the testing of the intelligence of Negro children have been discussed by Jenkins.³¹

²⁹ For a summary of the data on racial differences see T. R. Garth, *Race psychology*, 1931, New York, McGraw-Hill Book Co.

³⁰ R. Pintner and R. Keller, Intelligence tests of foreign children, *Journal of Educational Psychology*, 1922, 13, 214-222.

³¹ M. D. Jenkins, The intelligence of Negro children, *Educational Method*, 1939, 19, 106-112.

Jenkins showed that the test score a group of Negroes makes depends to a great extent upon the geographical area from which the subjects are recruited. He stated that in some southern localities as many as 40 points difference in I.Q. have been reported. Furthermore, there is a great deal of overlapping in individual scores, and differences within the groups are frequently greater than differences between groups. He also pointed out that white children in many mountain communities show average I.Q.'s far below those of Negro children in more favorable environments. Others³² have also shown that the length of school attendance, especially in a favorable environment, is closely correlated with the increase in I.Q.

An attempt has been made by some investigators to evaluate items of standard tests upon which various racial groups differ. For example, it has been reported that Negro children show higher scores on items involving an appreciation of color or rhythm. In general, however, there has been no evidence to show that various racial groups differ on given aspects of intelligence.

Birth Order

The position of a child in the family, that is, the order of birth, has been regarded by a number of psychologists as an important influencing factor in determining intellectual development. It has been considered particularly important from the standpoint of personality development, and many psychiatrists have emphasized birth order as an important etiological factor in the development of personality traits. For example, the oldest child supposedly develops some personality traits because of his dominance over his brothers and sisters, whereas the youngest develops given emotional and personality characteristics as a result of his peculiar relationship to his parents. Some claims have also been made regarding the influence of birth upon the biological and social determinants of intelligence. Other factors have also been taken into consideration in evaluating the influence of birth order. For example, the youngest

³² H. H. Long, The intelligence of colored elementary pupils in Washington, D. C., *Journal of Negro Education*, 1934, 3, 205-222.

child is frequently in a better economic situation than the first-born. Because of the bettered economic and social position of the family, the parents pay more attention to his academic attainment.

It is not easy to evaluate the factor of birth order because of the many complicating situations which must be held constant. The size of the family, the age of the mother, and the number of the other siblings are influencing factors in determining the intelligence of a given child. Sutherland and Thomson³³ made a study of eleven-year-olds and discovered that there is a slight tendency for the lower I.Q.'s to occur among later born. It has been shown, however, that the larger families have a lower average intelligence than small families, and therefore the slight tendency of the younger children to have lower I.Q.'s may be a factor of the size of the family rather than of the birth order. (The coefficient of correlation between the size of the family and the intelligence of the children is about —.20.) The age of the mother is also a factor. The larger the family the more probable that the later born will be handicapped by the physical condition of the mother. This is illustrated in cases of Mongolian idiocy where it has been shown that the common factor is the age of the mother. The average age of mothers of Mongolian idiots is about thirty-five, irrespective of whether they have had many or few children. The earlier studies, made before the beginning of the twentieth century, showed that a higher percentage of mental defects occurs among the first-born. Apparently the sampling techniques frequently determine the conclusions about the influence of birth order. For example, Dayton,³⁴ among others, found that the greatest frequency of mental deficiency occurred in "middle" children.

In an evaluation of the factor of birth order, it is necessary to make a careful selection of cases. Most of the studies were made of children in the public schools. This has been criticized on the basis that many children are not old enough to be in public school and also that mentally defective children may not

³³ H. E. G. Sutherland and G. H. Thomson, The correlation between intelligence and size of family, *British Journal of Psychology*, 1926, 17, 81-92.

³⁴ N. A. Dayton, Order of birth and size of family, *American Journal of Psychiatry*, 1929, 8, 979-1006.

be placed in school.³⁵ Another source of error is the selection of cases from incomplete families. If the youngest of three children is selected and he is considered as the youngest, there may be no check on the possibility that five or six other children may follow.

When the factors of size of family, economic and social status, and the intelligence of the parents are controlled, it has been generally found that the birth order is not an important etiological factor in the development of intelligence. The relatively large number of first-born who are defectives is in part due to the fact that many defective children have no siblings. The high frequency of mental deficiency in small families may be related to the factor of fertility. Another factor is the hesitancy of parents who have a defective child to have more children. Except for the specific factor of the age of the mother as an etiological basis of Mongolian idiocy, the investigations have shown no definite relationship between the age of parents and the frequency of mental deficiency.

The complex nature of the problem of the environmental influence upon intelligence does not allow for specific conclusions. It is obvious, however, that we can no longer take for granted that heredity is the most important determining factor in the manifestation of intelligence. The evidence is clear that the nature of the environment in which a child lives influences his intellectual achievement. It is also clear that the younger the child the greater is the influence of the environment. The evidence is somewhat contradictory in regard to the lasting influence of a change of environment when instituted at a young age. Some observers found that a good environment may temporarily stimulate intellectual growth but in finality the child who has an excellent environment may not develop to a greater extent than the child who has an average or even inferior environment. It seems logical to assume that the improvement of children under good environmental conditions such as is represented in good schooling and in good foster homes is due not to the improvement of basic intelligence, but to the facilitation

³⁵ See L. L. Thurstone and R. L. Jenkins, *Order of birth, parent-age, and intelligence*, 1931, Chicago, University of Chicago Press.

of the development of intellectual performance. The children whose I.Q.'s rise are hereditarily of greater capacity than the tests showed them to be before they are exposed to a good environment. When a child improves his I.Q. to the point where he can be reclassified from a dull to a superior, it is fairly certain that his basic capacity was sufficiently high to make that achievement possible under favorable circumstances.

It is evident that more longitudinal studies must be made in which the children can be observed from infancy to adulthood. In order to evaluate the influence of environment, it is also necessary that further studies be made of the importance of various factors in an environment. For example, is the factor of the kind and extent of schooling more important than the factor of the intelligence of the parents? Does the stimulation of other siblings influence intelligence to a greater extent than the stimulation which the child obtains from extensive pre-school attendance?

Chapter 5

INTELLIGENCE AND DELINQUENCY

Recent Findings

Surveys have shown that the rate of mental deficiency and retardation is greater among delinquents than among the normal population. It has been shown, however, that the higher rate cannot be accepted as a significant causative factor of delinquency and that many factors other than intelligence are important in creating delinquency. Defective intelligence has usually been overemphasized as a cause of delinquency because of the assumption that a mentally retarded person lacks insight into his problems and is thus unable to control his impulses. Although poor insight and impulsiveness may be important factors, psychological studies have shown that they are but minor factors in causing delinquent behavior.

There have been many theories regarding the relationship between intellectual defects and delinquency. Psychologists at one time believed that the mentally defective person is more likely to become delinquent because he is very suggestible and because he does not have sufficient understanding to avoid identification with delinquents. We now know that suggestibility is not characteristic of the mentally defective person. Furthermore, it has been shown that most delinquencies are purposeful, though not consciously so, and that the suggestibility of an individual does not wholly determine his involvement in anti-social behavior. Indeed, some investigators have shown that the normal child is probably more suggestible than the defective. This may be very desirable, because the normal child thus is able to respond to the various pressures of our society and to behave in a socially approved manner.

The first studies of mental deficiency as a possible cause of

delinquent behavior were made when investigators attempted to differentiate between mentally defective and mentally abnormal persons on trial in courts. The attempt to differentiate these persons was the result of controversies regarding the legal problems involved in sentencing those suspected of some mental aberration. A mental disease was considered a reason for finding an individual not liable to punishment, but mental deficiency as a specific mitigating condition was not accepted. It was believed at one time that every feeble-minded person was a potential criminal and that he should be apprehended before he actually engaged in criminal behavior. The first studies were made in reformatories and prisons. In 1901 Nibecker¹ reported the results of the examination of the inmates of a reformatory in Pennsylvania. He stated that 35 per cent of the boys were below normal mentality. Other studies appeared to confirm, with some exceptions, the studies of Nibecker and his predecessors. In general, the reports showed that the frequency of mental deficiency and mental retardation was at least 15 to 20 times as great among delinquents and criminals as among the general population.

With the introduction of the Binet type of intelligence tests a number of surveys were made of the intelligence of delinquents and of reformatory and prison inmates. Goddard, whose revision of the Binet scale was used extensively at one time, reported on one occasion that at least 50 per cent of delinquents were mentally deficient. Later he revised his statement but still considered that the rate of mental deficiency was extremely high among delinquents. An example of the findings during the early period of mental testing was the report by Eynon.² He claimed that 61 per cent of a given group of delinquent boys were below normal. Others also found from 60 to 75 per cent of the inmates of reform schools mentally deficient or retarded. Similar reports were published regarding the frequency of mental deficiency of children appearing in juvenile courts.

¹ F. H. Nibecker, The mental capacity of juvenile delinquents, *Proceedings of the National Conference of Charities and Correction*, 1901, 28, 262-268.

² W. G. Eynon, The mental measurement of four hundred juvenile delinquents by the Binet-Simon system, *New York Medical Journal*, 1913, 98, 175-178.

With the perfection of testing methods and with the introduction of more adequate tests fewer reports showed a high rate of mental deficiency among delinquents. An evaluation of the results of the test performance of delinquents showed that several factors were responsible for the early reports of a high frequency of mental deficiency. The first intelligence tests were loosely administered and were poorly standardized. Frequently, a single test was given to a child or adult under adverse circumstances. There was also a sampling loading which greatly affected the results. The prisoners or delinquents who were tested were from the poorest environments and had had very little formal education, and there was thus a selection of retarded individuals. The early investigators implied, however, that similar test results would be obtained in the cases of all delinquents and prisoners. As succeeding reports showed, the frequency of mental deficiency was not as high as previously believed. Efforts were consequently made by various investigators to classify delinquents in categories other than mental deficiency or normal intelligence. The earlier classifications categorized delinquents into the mental defectives, the psychopaths who were considered mentally abnormal but not sufficiently so to be classified as psychotic, and the so-called moral delinquents who were neither defective nor psychopathic and whose behavior was considered acquired rather than innate. William Healy, who founded the Institute for Juvenile Research in Chicago, then known as the Psychopathic Institute, was the first psychiatrist to study the multiple factors involved in the causation of delinquency. He attempted to define delinquency in terms of environmental or mental conflict causation rather than in terms of specific personality or intellectual abnormalities. Healy and others pointed out that a defective child was more likely to be brought to a clinic than a normal child with similar delinquent behavior. He also noticed that greater emphasis was placed upon intellectual defects when they occurred in delinquents, because most psychologists underestimated the frequency of mental retardation and deficiency in the general population. Furthermore, minor differences in the intelligence scores between delinquents and nondelinquents were considered signifi-

cant. For example, in one report the delinquents were found to have a median I.Q. of 75, and the nondelinquents, 86. This might at first be considered significant, but when the problem of selection is evaluated the difference of 11 points may have little significance.

Recent reports show that the frequency of mental retardation and deficiency is only slightly greater among delinquents than nondelinquents. An average of 7 per cent of mental deficiency has been reported for delinquents as compared to an approximate 3 per cent for nondelinquents. Some investigators have found a larger percentage, but this may be due to many selective factors. The Gluecks³ found approximately 13 per cent of delinquents to be defective and 17 per cent borderline defective.

TABLE 6
FREQUENCY OF I.Q. GROUPS AMONG DELINQUENTS
AND NONDELINQUENTS
(According to the Gluecks)

Class	Juvenile Delinquents		Massachusetts School Children	
	Number	Per Cent	Number	Per Cent
Normal and above.....	407	41.6	2,872	79.0
Dull (I.Q. 81-90).....	276	28.2	511	14.0
Borderline (I.Q. 71-80)....	168	17.1	199	5.5
Defective (I.Q. 70 and below)	128	13.1	56	1.5

The results of many investigations show that the frequency of mental deficiency and retardation in delinquent and criminal groups is partly determined by the origin of these groups. It has been found that the intelligence of inmates of penal institutions compares favorably with the intelligence of the general populations from which the prisoners originate. This is true of the majority of prisoners, although a substantial number are retarded or mentally deficient. There is evidence that the frequency of delinquency varies at different levels of intelligence.

³ S. Glueck and E. T. Glueck, One thousand juvenile delinquents, 1934, Cambridge, Harvard University Press, p. 102.

Ackerson⁴ found that the greatest frequency of arrests occurred in the 70 to 80 I.Q. group. The frequency of police arrests of children with conduct problems in which there was a legal element was greater at the higher levels of intelligence. Steinbach⁵ found that the frequency of delinquents with I.Q.'s between 61 and 70 was approximately 19 per cent; between 71 and 80, 35 per cent; between 81 and 90, 27 per cent; and between 91 and 110, 19 per cent. In a study of 600 juvenile delinquents,

TABLE 7
INTELLIGENCE OF JUVENILE DELINQUENTS
(According to McClure)

Classification	I.Q. Range	Number of Boys and Girls	Number of Boys	Number of Girls
Superior	110-119	6	3	3
Normal	90-109	125	95	30
Dull Normal	80- 89	156	126	30
Borderline	70- 79	165	116	49
Moron	50- 69	145	91	54
Imbecile	25- 59	5	4	1

McClure⁶ found that only 1 per cent of the children rated as superior, 21 per cent were in the normal range, 26 per cent in the dull normal, 27 per cent in the borderline defective group, and 25 per cent in the feeble-minded (moron and imbecile) group. McClure thus found no great differences in the frequencies in the various intelligence groups except in children of superior intelligence. The Gluecks found that the frequency of dull and backward children among juvenile delinquents was 28.2 per cent, and among school children, 14 per cent, in their survey of juvenile delinquents and the school population in Massachusetts. Of the juvenile delinquents 17 per cent were

⁴ L. Ackerson, *Children's behavior problems*, 1931, Chicago, University of Chicago Press.

⁵ A. A. Steinbach, Intelligence and juvenile delinquency, *Elementary School Journal*, 1934, 34, 691-697.

⁶ W. E. McClure, Intelligence of 600 juvenile delinquents, *Journal of Juvenile Research*, 1933, 17, 35-43.

found to be borderline defectives, whereas only 5.5 per cent of the school children were borderline defectives. Thirteen per cent of the juvenile delinquents were mentally defective, and only 1.5 per cent of the school population had I.Q.'s below 70.

Intelligence and Types of Problems

Many investigators believe that intelligence affects the type of antisocial behavior rather than its frequency. It has been shown that some forms of behavior disorders are peculiar to intellectually defective children. As an example, unsystematized truancy occurs more frequently in retarded than in normal children, whereas truancy of the premeditated type, in which several children are involved, occurs more frequently in intellectually normal children. Many studies have shown that girls in reformatories usually test much lower than girls in other institutions, such as prisons. Most of the girls in reformatories are there because of sex offenses, and evidence has shown that the majority are of low intelligence. Some psychologists have reported that approximately 50 to 60 per cent of women sex offenders are feeble-minded, and from 20 to 30 per cent are dull and backward. Criminologists have reported that felonies and sex offenses occur more frequently in persons of lower intelligence, whereas fraud and embezzlement occur more frequently in persons of normal or high intelligence.

Studies of school children have shown that problem children differ intellectually from those who are considered to be well-adjusted. Haggerty⁷ found that children who were regarded as behavior problems deviated in both directions from the normal range of intelligence. He found that the children who were of average intelligence presented the fewest behavior difficulties. This might be explained on the basis that the requirements of the average school are adapted to the abilities of the child of average intelligence. The average child thus fares better than the defective or superior child in his adjustment to the school requirements.

⁷ M. E. Haggerty, The incidence of undesirable behavior in public school children, *Journal of Educational Research*, 1925, 12, 102-122.

Socio-Economic Status

In evaluating the probable causes of the higher frequency of mental retardation and defect among delinquents, the factor of selection must be taken into account. It is known that delinquency is more frequent among children of low socio-economic status. This is due to a variety of factors such as erratic or undesirable training, relative irresponsibility of parents, unstable home life, direct and indirect effects of economic disorder, frequent migration, and so on. Thus, in effect, there is an unusual selection of children from socio-economic levels in which the environmental conditions tend to increase the frequency of delinquency. It appears, therefore, that the higher frequency of mental retardation and deficiency among delinquents than among the normal population may be due to a large extent to undesirable environmental and cultural factors rather than to the direct effects of intelligence. A number of careful studies have shown that the relationships between parents and their children in families of low socio-economic status are much less effective than in families of high status. The erratic discipline and the emotional disorders in the home, which many psychologists believe to be important factors in causing delinquency, are much more frequent in economically marginal or substandard families.

Chapter 6

INTELLIGENCE AND PSYCHOSES

Intellectual Changes

Studies have shown that there is no intellectual deterioration during the first few years of a functional psychosis. Deterioration nearly always appears in patients who have an organic psychosis. In the past it was assumed that intellectual deterioration always occurred in any type of a mentally abnormal patient. Indeed, the prognosis was usually assumed to be directly related to the degree of intellectual deterioration. The earlier studies of the intelligence of psychotic patients were, however, neither experimental nor objective. In most cases psychiatrists used random test questions and made subjective interpretations regarding the intelligence status of the patients. It has been only a short time since psychotic patients have been systematically tested and the results statistically evaluated.

One of the difficulties of testing psychotic patients is the inability of the examiner to obtain their attention and concentration. A patient may attend to a task for a few minutes and thereafter may refuse or be unable to concern himself with the task. The distorted symbolic activity, the mannerisms, the verbigerations, and many other forms of abnormal behavior may interfere with the psychotic patient's ability to respond to given tests. It is therefore difficult to define the exact mental level of a psychotic patient because the raw score on a test cannot give information regarding the nature of the deteriorative process. A psychotic patient may make a low score on a test of general intelligence, principally because he may fail every item in a given part of the test. He may succeed on every item in the section on general information and fail on most of the arithmetic items. In senile dementia, for example, memory for im-

mediately past events is poor whereas memory for remote events may remain fairly normal for a long time. A senile dementia patient may not be able to recall what he had eaten for breakfast but may recall many events in his childhood. In some schizophrenic patients judgment deteriorates quickly whereas memory, vocabulary, and arithmetical ability may show few changes. In the early stages of the schizophrenic psychoses, especially in children, judgment involving emotional elements tends to deteriorate whereas the type of judgment measured by tests may remain normal. Studies of juvenile schizophrenics have shown that the rigidity of emotional behavior determines the discrepancy between intellectual capacity and performance. When there is a definite dissociation between intellectual judgment, or reasoning, and emotional judgment, or judgment in personal-social situations, a child who may succeed on most of the tests involving judgment in a mental scale, such as the Stanford-Binet, may nevertheless be unable to do his school work adequately and may also show infantile and regressive behavior. His social judgments are poor and his ability to relate himself to others decreases as his dissociation increases. Dissociation between intellectual capacity and performance is also found in adult psychotics.

In spite of the evidence that many psychotic patients show only a pseudo-deterioration at first, there is also some evidence that there is progressive and lasting deterioration. This evidence may be inferred principally from the fact that many patients who recover from a psychotic condition cannot resume their previous level of performance. A young adult who recovers from a schizophrenic episode may thereafter behave on the level of a thirteen- or fourteen-year-old. Various factors obviously are involved in the mental deterioration of a patient whose psychotic condition has been of long standing. The social isolation, the lack of interest, the refusal to take part in ordinary intellectual activities, and the ordinary results of the forgetting process are factors determining the degree of deterioration.

Studies of recovered patients have shown that their intellectual level is usually lower than it was before the onset of the

illness. This has been found in both the organic and functional psychoses. The amount of discrepancy between intellectual levels before the onset of the psychosis and after recovery has been found to be proportionate to the seriousness of the illness and its duration. Statistical data are not as yet available for the schizophrenic patients who have been treated by metrazol or insulin shock therapy. Clinical observations have shown, however, that a larger percentage of patients treated by shock therapy resume their normal level of intellectual activity than patients whose recovery is spontaneous. Frequently the psychotic person behaves as if he were mentally deteriorated, but in many instances these patients are not fully recovered from their psychotic episodes. Discharge from a state hospital is naturally not a criterion of absolute recovery. The degree of recovery of a patient can be ascertained only by observing his behavior for an adequate period following his reorientation to a normal society.

Mental Deterioration

There is a prevailing belief that true mental deterioration is a constant concomitant of a mental disease, especially of the schizophrenic type. The longer the duration, the greater the degree of deterioration, although it has also been noted that a given level is finally reached beyond which there is no further deterioration. Duncan, Penrose, and Turnbull¹ made a survey of patients in a state hospital in which they compared the old patients with the new admissions. The patients were examined by mental tests. Most of the items were from Burt's Mental and Scholastic Tests. The past history and the school records were also ascertained. Among the many findings the authors discovered that the symptoms were frequently determined by the mental level. As an example, hallucinations, especially visual, were much more common in the patients of the lower mental levels in the manic-depressive group. They discovered that except for epilepsy the manic-depressive types were the most com-

¹ A. G. Duncan, L. S. Penrose, and R. C. Turnbull, *A survey of the patients in a large mental hospital*, *Journal of Neurology and Psychopathology*, 1936, 16, 225-238.

TABLE 8
PATIENTS IN A STATE HOSPITAL (RESIDENT POPULATION), JANUARY, 1935
(From Duncan, Penrose, and Turnbull, pp. 226-227)

Mental Grade	Schizo- phrenia		Organic		Manic- Depressive		Epilepsy		No Psychosis		Totals	
	M	F	M	F	M	F	M	F	M	F	M	F
Superior	6	12	5	5	2	1	2	1	16	1	15	19
Normal	252	441	135	211	44	107	21	16	1	3	453	778
Dull	143	164	40	45	27	36	16	10	6	3	232	258
Feeble-minded ..	57	58	6	11	26	38	15	17	23	28	127	152
Imbecile	2	5	1	...	1	5	12	6	29	25	45	41
Idiot .....	...	...	...	...	...	...	...	2	8	4	8	6
Total	460	680	187	272	100	187	66	52	67	63	880	1,254

Type of Disorder	Dull	Mentally Defective
Schizophrenia	26.9%	10.7%
Organic	18.5%	3.9%
Manic-depressive	22.0%	24.4%
Epilepsy	22.0%	44.1%
No psychosis	6.9%	90.0%

TABLE 9
1934 HOSPITAL ADMISSIONS
(Adapted from Duncan, Penrose, and Turnbull, pp. 228-229)

Mental Grade	Schizo- phrenia (33.3%)		Organic (40.8%)		Manic- Depressive (17.5%)		Epilepsy (4.3%)		No Psychosis (4.1%)		Totals	
	M	F	M	F	M	F	M	F	M	F	M	F
Superior (2.8%)	1	3	1	5	..	..	1	1	..	..	4	9
Normal (66.3%)	38	59	58	84	23	35	3	3	3	3	125	182
Dull (21.8%)	28	12	20	14	8	9	3	3	3	3	62	39
Feeble-minded (6.9%)	4	5	4	3	4	1	2	2	2	5	16	16
Imbecile (1.9%)	2	2	..	..	..	..	1	1	2	1	5	4
Idiot (0.2%)	..	..	..	..	..	..	..	..	..	1	..	1
Total	73	81	83	106	36	45	10	10	10	10	212	251

mon psychoses among the mentally defective. Duncan,² in a separate report, stated that the symptoms of a given psychotic group were generally unrelated to the level of intelligence except that hallucinations were more frequent among the subnormal. In the manic-depressive patients of normal intelligence there were about as many predominantly manic types as depressive. Among dull patients, however, the depressions were more frequent and in the feeble-minded the manic reactions were about four times as frequent as depression. Duncan stated that the chance of recovery from a manic attack or from depression did not seem to be influenced by the coexistence of a mental defect. The duration of the psychotic episode was not influenced by the mental deficiency. Relapses were much more frequent, however, in the feeble-minded, probably because of their basic instability.

Mental Testing of Psychotic Patients

A number of attempts have been made to measure the mental changes of psychotic persons. Babcock³ attempted to standardize thirty tests to measure the degree of deterioration of psychotic persons. These tests emphasized mainly speed of response and the fixation phase of memory because she noticed that these so-called phases of intelligence were affected in mentally abnormal persons. The results of the performance of normal subjects were compared with those of the abnormal, and the scores were transmuted into mental level values. One of the important criteria was an "efficiency index" from the difference between a subject's score and the norm for persons of his intellectual level. On the basis of observation after a three months' interval, Babcock found that the degree of deficiency and the gain on a retest correlated with the patient's improvement. Babcock stated, as others have previously, that the result on the usual test of intelligence is not a good index of the degree of deterioration. This is due to the differential deterioration, that is, a patient may be normal in some aspects of his intelligence

² A. G. Duncan, Mental deficiency and manic-depressive insanity, *Journal of Mental Science*, 1936, 82, 635-641.

³ H. Babcock, An experiment in the measurement of mental deterioration, *Archives of Psychology*, 1930, 18, No. 117.

and subnormal in others. In consequence, the total score on any standardized test may result in an erroneous interpretation of the degree of deterioration. One of the indices which Babcock emphasized was the difference between the efficiency of the psychotic person regarding his old associations and his ability in a new learning situation. Babcock's tests varied greatly, ranging from such items as general information and naming of months and days to reversal of digits and picture and word recognition.

Many other studies have been made in the attempt to discover the type and severity of the intellectual changes of psychotic patients. As has already been mentioned, the most difficult problem which confronts every investigator relates to the selection of the mental tests. Obviously, ordinary tests which involve precise memory of past experiences and require sustained effort cannot be used to measure the intelligence of psychotic patients. Simmins⁴ constructed a set of 20 nonverbal tests which varied in difficulty. They were designed to be presented to psychotic patients and were free of the disturbing influences of past experience. These tests were given to a group of nonpsychotic women. The results showed that no mentally defective subject scored better than 7, and no professional worker scored less than 17. When they were administered to the psychotic group, Simmins found that only one patient, a manic-depressive, scored as high as 17. Despite their low scores, at least twenty of the psychotic women patients had previously had careers requiring superior intelligence. About 40 per cent of the psychotics made scores as low as those of the nonpsychotic mental defectives. The *g* ability before the onset of the illness was estimated from vocabulary tests (Babcock method). The deterioration was estimated as the difference between the vocabulary score and the visual-perceptual tests of *g*. There was evidence that the incidence and amount of *g* deterioration was related to the seriousness and the duration of the psychotic condition. Those patients who were about to be discharged as recovered and the hysterical patients showed no *g* deterioration. In a later publica-

⁴ C. A. Simmins, Studies in experimental psychiatry : IV, Determination of "g" in psychotic patients, *Journal of Mental Science*, 1933, 79, 704-734.

tion Simmins⁵ reported the results of further testing by this method. Of 85 cases, 50.5 per cent showed deterioration. Harbinson⁶ continued the work of Simmins. He used the Terman vocabulary test and compared it with scores on visual-perceptual tests of *g*. He found, however, that over 70 per cent of the schizophrenics showed no deterioration.

TABLE 10
MENTAL CHANGES OF PSYCHOTIC PATIENTS
(From Simmins, p. 118)

Category	Number Tested	Per Cent Showing Measurable <i>G</i> Deterioration	Total Showing <i>G</i> Deterioration, Whether Measurable or Associated with Impairment of Other Cognitive Abilities
Manic-depressives .	12	41.5%	58.0%
Dementia praecox..	20	45.0	60.0
Delusionals	23	56.5	69.5
Manics	8	62.5	75.0
Melancholics	17	41.0	82.0
G. P. I. (malaria treated)	5	80.0	100.0
All cases	85	50.5	70.0

The Psychoses of Mental Defectives

The most extensive investigations have been made of defective individuals who developed a psychotic condition. The question has often arisen regarding the influence of intelligence upon emotional stability. In general, most psychologists believe that there is no direct relationship between intelligence and susceptibility to emotional disturbances except that under some circumstances an adjustment to normal society is more difficult for defective persons, especially in cases of the low-grade feeble-minded. Morrison⁷ reported, from a study of 228 subjects,

⁵ C. A. Simmins, Spearman factors and psychiatry: IV, The measurement of mental deterioration, *British Journal of Medical Psychology*, 1934, 14, 113-120.

⁶ M. R. Harbinson, An investigation of deterioration of general intelligence or "g" in psychotic patients, *British Journal of Medical Psychology*, 1936, 16, 146-148.

⁷ B. M. Morrison, A study of the major emotions in persons of defective intelligence, *University of California Publications in Psychology*, 1924, 3, 73-145.

that mental defectives are likely to be more easily disturbed emotionally than normal individuals. She studied 52 idiots, 68 imbeciles, 54 morons, and 54 borderline defectives in an institution. She reported that the expression of anger is frequent in all grades of mental defectives except in the lowest idiots. This type of behavior is not to be unexpected in institutionalized defectives. It is obvious that the emotionally disturbed mental defectives are institutionalized more frequently than those who are emotionally well adjusted.

In an investigation of the psychoses in mental defectives, Gordon⁸ reported two types. In one type the mental disturbance followed some intense emotional experience and the usual defective mode of thinking, feeling, and acting became intensified. The emotional and intellectual elements appeared dissociated, and the impulsive acts became more frequent and more intense with either extreme anger and violence or depression and timidity. In the second type the classical symptoms of the psychoses developed. The psychoses which Gordon observed were the paranoid states, the manic-depressive reactions, and the delirious or confusional states. The depressions were not profound and occurred without the usual deep anxieties. The manic types also differed from those of normal intelligence. The defective manics did not develop exaggerated self-esteem, nor did Gordon find rapid association of ideas. Hallucinations occurred more frequently, however, and were more persistent. The ideational associations in the paranoid states were defective. The self-deception was not as striking and spontaneous as in the patients of normal intelligence, probably because of defective ideational associations. In the defective paranoid patient there was no special tendency to refer external things to himself, or rapidly to form imperative ideas, or rapidly to create erroneous conceptions. The delusional ideas were therefore not easily developed and were not as elaborate as in the usual patient. In the confusional states there was much more vagueness and ideational dissociation than in patients of normal intelligence. Gordon thus showed that the psychotic states of mental defectives are in

⁸ A. Gordon, *Psychoses in mental defects*, *American Journal of Insanity*, 1919, 75, 489-499.

many ways different from the typical manifestations because of the fundamental intellectual defect. The difficulty which the defective patient had in forming and associating ideas modified his psychotic symptoms.

The large number of symptoms which some defective psychotics show have led some psychiatrists to believe that the feeble-minded are more likely than normal persons to develop psychotic symptoms. For example, Bartemeier⁹ believed that the feeble-minded have characteristics that may make the signs of feeble-mindedness emerge into a progressive psychotic disturbance, manifested by stereotypes, inclinations to impulsive acts, and emotional outbreaks. The progress of the disease did not differ, however, in the mental defectives. Other observers have also reported that a psychotic condition is a common complication of mental deficiency. Unless the psychosis is diagnosed, the patient is frequently placed among other feeble-minded persons with whom he does not properly fit. In low-grade defectives the diagnosis must be made on the basis of overt behavior because mental content is not readily available in other ways.

Surveys of many state institutions have shown that almost every type of psychosis is represented. The most common psychoses among mental defectives are associated with epilepsy. Butler¹⁰ found that epileptics frequently show symptoms of deterioration, slowness of association, irritability or apathy, and paranoid delusions and hallucinations. One group of epileptic psychotics manifested mainly "clouded" states. The patients were confused, frequently showed anxiety or excitement, with hallucinations, fears, and strong emotional outbreaks. Dementia praecox is also frequent in the feeble-minded. The psychotic patients do not differ essentially from those in ordinary hospitals for the insane except that they are less accessible and do not show as many symptoms. Butler found that these patients manifested episodes which were transitory, consisting of excitement, depression, paranoid trends, and hallucinations which were stimulated by minor events in the environment. The manic-

⁹ L. H. Bartemeier, *Psychoses in feeble-minded*, *Proceedings of the American Association for the Study of the Feeble-minded*, 1925, 49, 314-324.

¹⁰ See F. O. Butler, *Psychosis in the mentally defective*, *California and Western Medicine*, 1937, 46, 84-89.

depressive psychoses usually occurred in patients of higher intelligence.

An adequate survey of the psychoses of mental defectives is difficult to make because of the inability to obtain the mental content of the low-grade mental defectives. Hayman¹¹ found that the psychoses are much more definitely manifested in high-grade mental defectives. In the defectives Hayman found that the motor phenomena are much more prominent than in psychotics of normal intelligence. The psychotic conditions are more episodic and disturbances of consciousness are more frequent. In the cases which Hayman studied, there was a tendency to deterioration and a final adjustment at a lower level. Hayman found 21 schizophrenics and 5 manic-depressives in a group of 50 patients.

A number of studies have also been made on the incidence of defectives in hospitals for the mentally insane. Pearson¹² reported that 3.6 per cent of all admissions to the Massachusetts hospitals for mental diseases for the year ending September 30, 1936 were psychoses associated with mental deficiency. Of the total resident hospital population, 7.5 per cent were mentally defective. He found that in the idiots the chief disorder was on an organic level. The patients were excited, destructive, untidy, restless, aggressive, and frequently mute. Their memory span was exceedingly poor. The psychotic imbeciles showed the same type of symptomatology. Their erratic activities tended to be episodic rather than constant and prolonged. At the level of the moron the symptoms became more readily grouped. Their reactions simulated those of the nondefective psychotics. In general, therefore, the symptoms differed according to the differences of intelligence. Hunsicker¹³ attempted to classify the psychotic manifestations of mentally defective patients on the basis of their intelligence levels. He classified the patients into five groups. In Group 1 the patients had I.Q.'s up to 18. For

¹¹ M. Hayman, The interrelations of mental defect and mental disorder, *Journal of Mental Science*, 1939, 85, 1183-1193.

¹² G. B. Pearson, The psychoses of mental deficiency as viewed in a mental hospital: clinical syndromes, *Proceedings of the American Association on Mental Deficiency*, 1938, 62, 166-172.

¹³ H. H. Hunsicker, Symptomatology of psychosis with mental deficiency, *Proceedings of the American Association on Mental Deficiency*, 1938, 62, 51-56.

the most part they showed motor phenomena such as irritability, restlessness, facial grimaces, physical mannerisms, destructiveness, resistiveness, and partial disorientation. In Group 2, with I.Q.'s from 24 to 40, many of the same symptoms appeared but in addition there were visual hallucinations, persecutory delusions, religious delusions, seclusiveness, depression, exhibitionism, and negativism. In Group 3 the I.Q.'s were from 40 to 52. In these patients the symptoms were similar to those of the usual psychotic patients. In addition to many symptoms of the other two groups, auditory hallucinations, antagonisms to the family, sadistic reactions, suicidal tendencies, and fantasies were observed. In Group 4, the I.Q.'s ranged from 53 to 68. Hunsicker noted fears, hallucinations, delusions, evidence of hysterical reactions, and other symptoms which are frequently observed in other psychotic patients. In Group 5, the I.Q.'s were from 72 to 75. The most frequent symptoms were homosexuality, depression, and apprehension. In a survey of the Laurelton State Village for adult mental defectives in Pennsylvania, Vanuxem¹⁴ found that of 976 patients who were admitted between 1920 and 1935, 76 developed some type of psychosis. Of these patients 33 were schizophrenics and 35 were classified as manic-depressives. A number of other investigators have also found that the frequency of psychoses in patients in institutions for the feeble-minded is greater than was previously believed. In the Fernald State School, for example, over 12 per cent of the patients showed evidence of a psychotic condition.

Most investigators found a great deal of difficulty in making a definite diagnosis. Various symptoms, such as apathy, mutism, and negativism, have been considered by some psychiatrists as evidence of a psychotic condition and by others as behavioral episodes related to mental deficiency. Symptoms of a definite mental dissociation are not always manifested, and the investigator cannot be certain of the nature of the symptoms principally because it is difficult to obtain a clear understanding of the mental content of the mentally defective person.

¹⁴ M. Vanuxem, *The prevalence of mental disease among mental defectives*, *Proceedings of the American Association on Mental Deficiency*, 1935, 59, 242-252.

The case of a boy of eight who was studied intensively at the Orthogenic School for a nine-month period illustrates the difficulty of a differential diagnosis between schizophrenia and mental deficiency. The birth was uneventful and he developed normally during infancy. According to his mother, he walked at one year and talked in sentences at sixteen months. His only serious illnesses were measles at the age of six and whooping cough at the age of seven. His parents became concerned with him because he did not seem to make progress in talking after he was three years old. At the age of five he entered public-school kindergarten but was sent home at the end of a week because he could not follow directions. When he was seven he entered a private school but the teachers reported that he acted peculiarly.

When he was first examined he gave the impression of being a mentally defective child. His speech was slurred, he was hyperactive and he responded with monosyllables to questions. Some aspects of his behavior appeared, however, distinctly different from those of the ordinary mentally defective child. To some questions he responded as adequately as any normal eight-year-old boy. At times he repeated questions but did not give an answer. The staff of the Orthogenic School reported that he usually played alone but was nevertheless aware of what the other children were doing. For example, he frequently built a train or a house out of blocks, and after finishing his task he invited other children to look at his work. A good deal of his activity consisted of drawing with pencil or crayon. One of the teachers reported that his drawings were excellent for a boy of his age. In the schoolroom he did poor work but on occasions surprised the teacher by his good insight. The teacher had difficulty in keeping him quiet in the schoolroom. Although his attention span was often long, he frequently stopped his work and sat as if he were daydreaming. With the exception of his irritability when other children interfered with his activities, he maintained an even emotional level which gave the appearance of contentment and satisfaction. He rarely complained about other children or about his treatment. On the basis of intelli-

gence tests he showed a fluctuation between an I.Q. of 72 on the Stanford-Binet test and 102 on the Arthur Point Performance Scale. Analysis of his performance showed that his low score on the Stanford-Binet was due to his lack of attention and his inability to respond verbally in an intelligible manner. The diagnosis became clearer after several months of observation and treatment. When his irritability was reduced and his attention span became longer, he was more able to do his school work. On occasions he was able to converse in an intelligent manner without lapsing into answering irrelevantly or merely repeating the questions which were asked of him. There were no signs of any neurological disturbance.

This boy was diagnosed as a juvenile schizophrenic. The mother had been suspected of having a mild schizophrenic condition and an older brother had been in an institution because of his psychotic condition. If continued observation had not been made of this boy, the diagnosis would have been mental deficiency. The variability of the level of his intellectual responses, his mannerisms, his compulsive behavior, the irrelevancy of his responses, and the mental blocking and high I.Q. obtained on performance tests were the signs which differentiated him from the ordinary mental defective.

Mannerisms are relatively frequent in the mentally defective adult but whether they are related to the mental deficiency or to some psychotic episode cannot be easily established. In many cases a diagnosis is made only when the psychotic mental defective shows signs of destructiveness and violent temper. James,¹⁵ for example, found that a large number of mental defectives had violent dispositions. In his survey he found that 11 per cent of these individuals had definite signs of a psychosis, and of this group 75 per cent were classified as dementia praecox. James believed that although the pathology of dementia praecox is nonspecific, there is a probability that the brain pathology of this type of psychosis and of mental deficiency is similar.

¹⁵ S. G. James, The relationship of dementia praecox to mental deficiency, *Journal of Mental Science*, 1939, 85, 1194-1211.

Types of Psychoses of Mental Defectives

Although most investigators have shown that the psychoses of mental defectives are different from those of the mentally normal because of the intellectual factor, some psychiatrists believe that the abnormal neural structure of the mentally defective person results in a different type of psychotic condition than that of the normal. Berkley,¹⁶ in a report in 1915, implied that the cytoplasmic structural defects of the imbecile resulted in a type of insanity which is radically different from that which occurs in the normal person. He believed that during adolescence the various strains and tensions cause a disturbance of neural viability and thus predispose the adolescent to insanity. These insanities are different from the classical forms both in symptomatology and duration. He classified the types in terms of their resemblance to the classical types of insanity, as follows:

1. The dementia praecox group.
2. The alternating insanities such as the circular forms, stuporous states, and the excitements.
3. The dementia types.
4. Acute and chronic hallucinosis.
5. Acute and chronic delusional states.
6. Obsessions and pathological impulses.

He stated that the imbecile psychotic shows a tendency to quick dementia. Many of the psychotic episodes are of short duration and the onset is also more sudden than in the mentally normal person. He found that terminal dementia rather than recovery was the general rule. In regard to the clinical manifestations he classified eight types:

1. States of pathological exaltation of short duration and rapid termination in dementia. Frequently these periods are complicated by alternating attacks of depression. The delusions are infrequent and when they do occur are of a very simple type. There is a sudden onset, tendencies toward violence, and some degree of confusion.

¹⁶ H. J. Berkley, The psychoses of the high imbecile, *American Journal of Insanity*, 1915, 72, 305-314.

2. States of pathological exaltation with confusion and simple delusions. The false ideas persist unvaried for some time and hallucinations are common. Eventually the patients deteriorate to a low level.
3. Patients who continue with their confusion following a period of hyperactivity with delusions and hallucinations. This ends in stupor with catatonic rigidity and negativism and frequently death follows.
4. Psychotic conditions in which paranoid tendencies are frequently the result of alcoholism. These patients require institutionalization and usually show a continuous retrogression.
5. The manic-depressives in whom the excitability is more frequent than depression. The excitements have a sudden onset, are of short duration, and are marked by a deeper clouding and confusion than are present in the usual manic-depressive patient.
6. Stupor states. These patients become irritable and restless for a short period and then may suddenly pass into a deep, passive sleep.
7. Regressive dementia without active motor or psychic symptoms. In the early stages there is an ill-defined nervous agitation without definite delusions or hallucinations. Later the patients show a progressive dementia without further active symptoms.
8. Chronic states of delusions and hallucinations which occur in patients as the result of the use of drugs and alcohol. These delusions are generally of a persecutory type.

The predominance of motor phenomena, which has already been mentioned, is especially prominent in patients with a serious mental retardation. In reporting upon a series of cases of catatonia in idiots, Earl¹⁷ emphasized the occurrence of deterioration and the concomitant development of deep catatonic states. Earl's study was based on 135 low-grade male idiots. They manifested a variety of crude and bizarre motor patterns

¹⁷ C. J. C. Earl, The primitive catatonic psychosis of idiocy, *British Journal of Medical Psychology*, 1934, 14, 230-253.

especially of the trunk and arms. Many of the movements were repetitive and as the condition progressed became rhythmical. The patterning of the motor phenomena was described by Earl as a primitive catatonic psychosis. Those showing catalepsy assumed a typical schizoid habitus, automatic obedience, and in many cases echolalia and sometimes echopraxia. Autisms were marked and some degree of mutism was always found. Negativism also was common.

There has been no adequate explanation of the neurological basis of intellectual deterioration in the "functional" psychoses. Deterioration can be readily explained on a neurological basis in cases of senile dementia, paresis, and other organic conditions in which cortical pathology has been demonstrated. Presumably, except in long-standing cases, schizophrenic patients do not show localized cortical pathology. Some neurologists maintain that in spite of the inability to demonstrate this pathology microscopically, it may nevertheless exist. There may, for example, be a change in the blood supply which causes neural changes not easily demonstrable in the laboratory. Or the deterioration may be due to chemical changes, the nature of which is almost entirely unknown.

Chapter 7

CLASSIFICATION OF MENTAL DEFICIENCY

Frequency and Types

The number of mental defectives in this country has not been accurately determined. Many feeble-minded children and adults are in private sanitaria and schools, others are sufficiently well adjusted to remain at home, and the remainder are in public institutions. Only the low-grade mental defectives are usually committed to a state institution except when some behavior disorder occurs. In a survey made in 1936 it was disclosed that 111,559 mentally deficient persons were on the books of institutions at the beginning of the year, of whom 14,562 were on parole or under observation outside of the institutions.¹ This number included epileptic patients who as a rule were mentally deteriorated. From 1931 to 1936, according to this survey, the resident population in state institutions rose sharply. This was due in part to more stringent regulations regarding commitment and in part to increased facilities. In interpreting the rate of admissions and discharge from state institutions, it is important to note that many institutions are overcrowded and frequently send children back to their parents even though there has been very little therapeutic result from institutionalization.

Mental deficiency is generally defined as a condition in which the individual is unable to care for himself adequately without undue help from adults. An etiological definition is difficult to make because the causes vary greatly and there is no uniformity of type. Psychologically, the mentally deficient person is one whose I.Q. is below 70. This is probably the most adequate definition because it transcends etiological classifications. The

¹ Mental defectives and epileptics in institutions, 1938, Washington, D. C., Government Printing Office.

classification in terms of I.Q.'s is generally considered to be as follows:

Above 110	Superior, very superior, near genius, genius
90-110	Average or normal
80-90	Dull and backward
70-80	Borderline defective
48-70	Moron
28-48	Imbecile
Below 28	Idiot

Obviously this classification is entirely arbitrary. Theoretically the various diagnostic categories have been determined by means of statistical analysis of frequencies but when the data of the various studies which determined these classifications are analyzed it can be seen that they are not adequate. For example, it may be just as feasible to consider the borderline defective in the range of I.Q.'s between 65 and 75 and the dull and backward group between 75 and 85. Indeed, a large number of psychologists are now using the I.Q. range of 75 to 85 for the classification of the dull and backward. The problem of the exact grouping of I.Q. classifications is not of great importance, however, if those who use these classifications are not unduly influenced by them. For example, the administrators of some schools at one time believed that a child with an I.Q. of 85 could not successfully complete the eighth grade. This attitude has changed, however, first, because the exact I.Q. level is important only in relation to the range of the I.Q.'s of the other children, and second, because factors other than a given degree of intelligence have been found to be almost as important in determining academic success, except when the I.Q. is below 70. For purposes of treatment the moron and imbecile groups are also classified as low grade, middle grade, and high grade.

Although the behavior of mentally deficient persons does not differ in most cases from that of normal individuals, many defectives manifest deviant, stereotyped behavior. A classification of behavior does not imply that the basic cause is similar in all cases. The psychiatric and educational care, however, may be determined by the behavior pattern of the defective individual.

The behavior of mental defectives may be classified in the following general categories:

1. The well-adjusted, normally responsive defective. His social difficulties are determined mainly by his lack of normal intelligence and not essentially by personality or emotional disturbances.

2. The verbal type. This type of mental defective differs very little from the first type except that his language usage is superior to his general intelligence. His social behavior is consequently on a higher level than would be predicted from his intelligence test scores.

3. The excitable type. This type is irritable, restless, aggressive, and destructive. Stimuli which ordinarily arouse little response in the normal child cause intense emotional reactions. There is very little relationship between the organic findings of the central nervous system and the degree of excitability. The largest number of excitable children occurs in the hereditary or so-called constitutional defectives in whom there are usually no significant organic or central nervous system disturbances.

Various clinical classifications of mental deficiency have also been made. Potter² classified mental deficiency into the following types:

1. The constitutionally mentally deficient individual. This type is considered to be due to a general biological inferiority. Potter believed that the majority of these individuals show various stigmata such as facial and skull asymmetry, imperfectly formed or irregularly erupted teeth, protruding or receding jaws, and other anomalies. Potter subdivided the constitutionally mentally defective group into the following subtypes:

- (a) The familial type, in which there is supposedly evidence of direct or collateral ancestral defect.
- (b) The Mongolian type, which is defined mostly by physical characteristics such as flattened skull, oblique and nar-

² H. W. Potter, A clinical classification of mental deficiency, *Psychiatric Quarterly*, 1930, 4, 567-578.

row palpebral fissures, depressed nose, fissured tongue, short hands, paddle feet, and so on.

- (c) Congenital diplegic type, in which there may be bilateral rigidity and spasticity. Potter believes that this type shows many defects in myelinization.
- (d) The microcephalic type, which is supposedly due to or accompanied by cerebral hypoplasia.
- (e) Oxycephalic type, in which the high, narrow skull is usually due to premature synostosis of the coronal and sagittal sutures.
- (f) Cretinous type, in which the growth defects, both physical and mental, are due to a deficiency of thyroid secretion.
- (g) Hypophyseal type, which is due to an insufficiency of pituitary function with dystrophy, frequently of the Fröhlich type.
- (h) Hypoplastic type, in which the general hypoplasia cannot be attributed to any one endocrine gland.
- (i) The constitutional syphilitic type, which apparently results from the blastophthic effect on the germ cell.
- (j) The undifferentiated type, which accounts for a large number of cases not definitely classifiable etiologically.

2. The reactional types, which are not constitutional but are the result of an organic reaction based upon mechanical, chemical, and bacterial factors. These types are frequently accompanied by physical defects. The following are the subtypes of the reactional mentally deficient group:

- (a) Post-traumatic conditions, usually cerebral lesions due to injury, especially birth injury.
- (b) The post-encephalitic type, occurring after acute infectious diseases and especially following epidemic encephalitis.
- (c) Hydrocephalic type, which is almost always secondary to inflammations about the aqueduct of Sylvius, the foramina of Luschka and Magendie, or the subarachnoid cisterns.
- (d) Infantile cerebral syphilis, in which the pathology may be meningo-vascular or parenchymatous. The intellectual

defect usually depends upon the location and extent of the lesions.

3. The degenerative mental deficiency types. The subtypes are as follows:

- (a) Diffuse sclerosis, in which there may be diffuse or patchy proliferation of the neuroglia of the cortex. Distinct changes in motor and reflex activity are observed.
- (b) Nodular sclerosis, which involves proliferation of a nodular type.
- (c) Amaurotic degeneration.

There have been many other attempts to classify mentally deficient persons. For example, Lewis³ classified mental deficiency into the pathological and subcultural types. The pathological type includes mental deficiencies due to traumatic causes, inflammatory conditions, hydrocephalus, epilepsy, syphilis, cretinism, and nutritional and sensory defects. Lewis also included in this group Mongolism, amaurotic family disease, progressive lenticular degeneration, naevoid amentia, and sclerotic amentia. The subcultural group is due to hereditary causes, and may include extreme variations of deficiency.

Mention has already been made of the heterogeneity of mental deficiency. For practical reasons it is advisable to define a mentally defective person as one who has an I.Q. below 70, whatever the cause may be. Myerson⁴ believes, as do other psychiatrists, that feeble-mindedness represents a heterogeneous group of conditions having in common a low intelligence. Otherwise, the conditions represent almost entirely separate entities and for the most part are biologically unrelated. Myerson classified patients at Waverly into the following groups: cretins, Mongolians, organic brain disease, microcephalics, congenital syphilitics, and the unclassified types. The last group probably includes the primary amentias, in which no known organic condition exists and which are thought of in terms of

³ E. O. Lewis, Types of mental deficiency and their social significance, *Journal of Mental Science*, 1933, 79, 298-304.

⁴ A. Myerson, The nature of feeble-mindedness, *American Journal of Psychiatry*, 1933, 12, 1205-1226.

hereditary defects. Myerson believes to some extent that mental deficiency involves a general organic deficiency. The institutionalized mental defectives show a large number of physical inferiorities. The defects were greatest in the groups of lowest mentality. Nevertheless, there are many cases in which there are no physical abnormalities.

The following psychological classification has been used extensively among clinical psychologists:

1. The amentias, in which the mental deficiency has existed from birth or so soon after birth that the mental growth has consistently been less rapid than in normal persons.
2. The deteriorative amentias, in which actual mental deterioration has taken place. This type is illustrated in the senile amentias, in the epileptics, and in the post-encephalitics.
3. The decelerative type, in which there is no actual mental age deterioration but a decrease in the I.Q. occurs with increasing age. For example, a child may develop at or near the normal rate until he attains a mental age of eleven but thereafter may show no gain in mental age. In spite of the fact that he shows no decline in actual mental age, his final I.Q. when he matures may place him in the mentally defective group.

Clinical Types

The following clinical types are proposed as a classification for etiological and therapeutic purposes:

1. The hereditary type, in which there is usually little, if any, organic disturbance. The diagnosis is generally made because no organic or environmental causes are discovered. Since feeble-mindedness cannot be thought of as a unit character of heredity, it is supposed that various germ plasm disturbances may be the specific cause for the failure of intelligence to develop at the normal rate. The following genetic factors have been proposed to explain the hereditary type: (a) neuropathic parents or ancestry; (b) parental alcoholism; (c) consanguinity. The evidence which exists at present regarding neuropathic

inheritance is extremely meager. Studies of given groups, such as the Jukes and the Kallikaks, were interpreted in the past in terms of an hereditary predisposition to feeble-mindedness. The neuropathic inheritance concept is supposedly corroborated by the high frequency of illegitimacy, economic inadequacy, and criminality among the members of these families. The effect of alcoholism has been discussed in the literature extensively without definite conclusions. In animals specific structural and behavioral defects have been observed as a result of chronic alcoholism. The progeny of alcoholic animals, for example, have shown frequent instances of structural and growth deviations. Among the offspring of alcoholic ancestry, however, there are a large number of normal and sometimes superior animals. Similarly, some children of alcoholic parents have been found to be superior whereas others have had defects. Consanguinity has been shown to be only a minor factor in the causation of mental deficiency. In spite of many legal restrictions, on the assumption that intermarriage produces mental abnormalities, it has never been shown clinically or experimentally that marriage among relatives is a definite factor in the production of mental deficiency. Other factors relating to the hereditary type of mental deficiency have also been considered. The age of the parents, for example, has been considered an important factor. There is no clear-cut evidence for such an assumption. There is some indication that extremely young parents or very old parents may produce children in whom the frequency of mental deficiency is somewhat greater than in the general population. Large differences in the ages of parents have also been considered important factors, but the evidence shows that this factor is of no great importance. There have been many biological explanations of feeble-mindedness in terms of germinal abnormalities. Davenport,⁵ for example, considers the feeble-minded as characterized by general subnormal development. He lists, as causes, defects arising in germ cells, defects associated with fertilization, defects associated with implantation, defects arising in the embryonic and in the fetal periods, defects arising from birth

⁵ C. B. Davenport, Causes of retarded and incomplete development, *Proceedings of the American Association of Mental Deficiency*, 1936, 60, 208-214.

injuries, and he also gives a miscellaneous group of post-natal causes.

2. The structural defectives. This type includes the birth injuries, the hydrocephalics, and the microcephalics.

3. The physiological defectives. This type includes the cretins, the hypopituitary types, and the severe nutritional disturbances.

4. The pathological types. This type is illustrated by the cerebral lesions due to infectious diseases, the post-encephalitics, the tuberous sclerotics, and the post-meningitis conditions.

5. The sensory defects. Under certain conditions given sensory defects such as blindness and deafness may be the basis of mental deficiency, although in most instances only retardation rather than deficiency results from sensory defects.

6. The environmental types. In mountain areas, in isolated rural environments, and in other extremely isolated situations, children may develop intellectually at an extremely slow rate. It is possible, of course, that their basic intelligence may be higher than their test results, but they are, nevertheless, from a practical and clinical standpoint, necessarily classified as defectives.

7. Mongolian idiots. As we shall see later, Mongolian idiocy is considered due to a fetalism, that is, incomplete intrauterine development.

8. The hereditary pathological type, such as amaurotic family idiocy.

Organic Defects of Mental Defectives

In the previous discussion some of the literature on the frequency of physical defects was analyzed. It was shown that no clear-cut evidence has been produced to indicate that the frequency of physical defects and of organic brain diseases is greater in mentally deficient children than in normal children. It is true that institutionalized children show a high rate of physical defects. This high frequency may be affected, however, by the necessity to institutionalize those children who are physically inferior or whose organic brain defects increase their difficulty of adjustment. As we shall see later, some psychologists

have emphasized the relationship between the frequency of mental deficiency and birth injury. It is important to remember, however, that in many of the cases in which birth injury is considered an etiological factor the diagnosis is made not in terms of the actual physical or neurological findings but inferentially on the basis of the history. On a logical basis it has been assumed that the brains of defective individuals must of necessity be less developed than those of normal persons. There is some evidence from post-mortem histological examinations that specific or generalized lesions and maldevelopment frequently occur in the defective person. There is an impression, however, among some pathologists, that the reported cases are the unusual or selected ones.

The most common emphasis regarding the pathology of defective children is on the nature of the cortical disturbances. There is a great deal of contradiction, however, in the literature regarding the nature and extent of cortical disturbances in defective children. Some pathologists have been unable to find specific brain pathology areas, and others have reported typical pathologic conditions. Eley,⁶ for example, stated that the development of the cortex of defective children is quite different from that of normal children. He believed that a large number of mental defectives are the result of some structural developmental defect or injury to the brain. He stated that there is usually a loss of the normal convexity of the hemispheres, and that there is hypoplasia of the entire cortex but especially of the parietal and occipital lobes. Although the number of convolutions is rarely reduced, they vary in size and shape. He believed that the frequency of internal hydrocephalus, porencephaly, and atrophic sclerosis has been underestimated.

Other neurologists have also reported significant differences between the structure and therefore the function of the brains of defective children and those of normal children. These differences supposedly determine the intellectual differences. Berry⁷

⁶ R. C. Eley, Neurological conditions in infants and children, *Journal of Pediatrics*, 1933, 3, 781-796.

⁷ R. J. A. Berry, Some of the structural abnormalities presented by the brains of thirty-one certified mental defectives, *Journal of Neurology and Psychopathology*, 1935, 16, 54-69.

reported on a series of tracings of the right hemispheres of a series of 31 brains of defectives. The measures were the angle of the Rolandic fissure, the length of the fissure, the height and index of the skull and brain, and the actual size of the cortical hemispheres. He found, as others have previously, that the size of the brains of defective individuals varied from 61 per cent to 103 per cent of the lowest available normal figures. There was a measurable disproportion between the main pre- and post-Rolandic cortical constituents most noticeable in the parietal region. Berry assumed that these persons lacked proper proportion of receptor and effector cortices, and therefore a diminished sensibility and perception of the external world.

In general, the reported differences between the brains of defectives and of normal children have been due mainly to a peculiar selection of cases and the failure to control given factors. As an example, differences in cortical measurements are usually due to differences in body size, that is, they are parallel to other somatic and skeletal differences. The assumption that the thickness of the supragranular layer is related to intelligence has never been verified. It has also been reported that the infragranular layer does not differ very much in defective individuals and indeed may be thickened. This is supposedly due to the fact that this area is the oldest phylogenetically and ontogenetically and is related to reflexive and primitive forms of behavior. The cell counts made by a number of investigators have shown no significant correlation between the number of nerve cells in the supragranular layer and the degree of amentia.

Reports that mental defectives show anatomical defects in proportion to the degree of mental deficiency have not been verified. The observations of Gray,⁸ for example, showed that no such relationship exists. He reported autopsy findings on 38 unselected cases, representing nineteen idiots, fifteen imbeciles, two morons, and two borderline defectives. There were a number of atypical findings, but the author pointed out that these are sometimes found in the brains of normal people. The brains of ten idiots, six imbeciles, two morons, and two borderline

⁸ E. W. Gray, An anatomical study of the brain in the feeble-minded, *Proceedings of the American Association on Mental Deficiency*, 1933, 57, 162-171.

defectives showed no anatomical anomalies. He concluded that although a large percentage of the brains of low-grade mental defectives show minor atypical structural conditions, there is no indication that gross developmental anomalies play an important role in the etiology of feeble-mindedness. In spite of the negative anatomical findings, some pathologists believe that there are intrinsic differences between the brains of normal and mentally defective persons. Meyer and Cook⁹ reported that mental defectives show a good deal of gliosis which accounts for their deficiency. They studied 22 cases and found a relatively constant proliferation of the glia. The cortical changes were, in most cases, relatively slight. The gliosis was diffuse or patchy and often perivascular. When there was maldevelopment, the cortex was free of gliosis except for occasional subpial gliotic proliferations. They implied that the pathogenesis may be related to defective oxygenation. It is known, for example, that in the developing brain the white matter is more susceptible to oxygen deprivation whereas in the adult brain the cortex is more vulnerable.

Distortions in the cell relationship have also been reported. It has been shown that the glial cells arise from a single zone of the germinal cells as do the neuroblasts. Therefore, according to some investigators, the functional inferiority of the defective's brain seems to be more of a pathological process than a simple failure of development. There is somewhat more evidence that the brains of defective individuals show irregularities of cell arrangement than a deficiency in number.

✓ If mental deficiency is to be explained in organic terms (except for specific organic or pathological conditions), it may perhaps be described in terms of a deficient functional integration. It is possible that the brains of mentally defective persons may be chemically deficient. Although in most cases chemical analyses of the brains of defective persons have shown no differences from those of normal individuals, there have been reports that the water content of the brains of defectives is higher than that of normals. They are also relatively larger in

⁹ A. Meyer and I. C. Cook, Diffuse white matter gliosis in mental defectives, *Journal of Mental Science*, 1937, 83, 258-267.

protein phosphorus content. It is possible that the increase in the nucleo-proteins is due to the relatively greater neuroglia. They may indicate that the nerve cells of the cortex of the mentally defective person are immature in form with less cytoplasm.

✓ The pathology in a given diagnostic type may vary greatly. For example, the pathological findings in Little's disease may vary from a combination of atrophic and inflammatory changes to hydrocephalus and porencephalus. Similarly, in microcephalus, pathologists have shown¹⁰ that various combinations of pathology may occur. One microcephalic brain may show inflammatory and atrophic changes, another an atrophic sclerosis, and a third, a gross anomaly of the brain. Many microcephalic brains show no gross and very few microscopic changes.

¹⁰ A. N. Bronfenbrenner, Correlating morbid anatomy and clinical manifestations in the feeble-minded, *Proceedings of the American Association on Mental Deficiency*, 1933, 57, 180-192.

Chapter 8

MENTAL DEFICIENCY AND SPECIFIC BRAIN PATHOLOGY

As we have seen in Chapter 7, histological studies have shown that there is no brain pathology in many types of mental deficiency. There are a number of types, however, in which brain pathology has been demonstrated to be the cause of the mental deficiency. This does not mean that there is a direct relationship between the extent of a brain lesion and the degree of mental deficiency. A serious mental defect may result from a moderate brain lesion, whereas a more extensive brain damage may result in only a slight mental deficiency, except in cases of massive brain damage due to injuries or skull fractures.

Birth Injury

In recent years numerous studies have been made of the effect of birth injuries upon the production of mental deficiency. The large number of difficult labors has impressed psychiatrists with the possibility that many infants sustain injury which may not be immediately observable. It is now known that birth injuries which may not result in overt signs may nevertheless be sufficiently serious to produce cerebral disorders which, in turn, may cause a disturbance of intellectual growth. Obstetricians have called attention to the fact that even a normal birth process may result in injury to the infant. Formerly, attention was paid only to births in which manual or mechanical aids were necessary, especially high forceps. It has been shown, however, that a very rapid birth may also result in injury.

The birth histories of mentally defective children have generally not verified the current belief that a large number have had birth injuries. In a study of 350 patients in a Philadelphia

institution, Patten and Matthews¹ found that 50 per cent were neurologically normal, that is, there were no signs of pyramidal, extrapyramidal, or sensory impairment. Those without neurological findings were mostly of higher intelligence levels, and

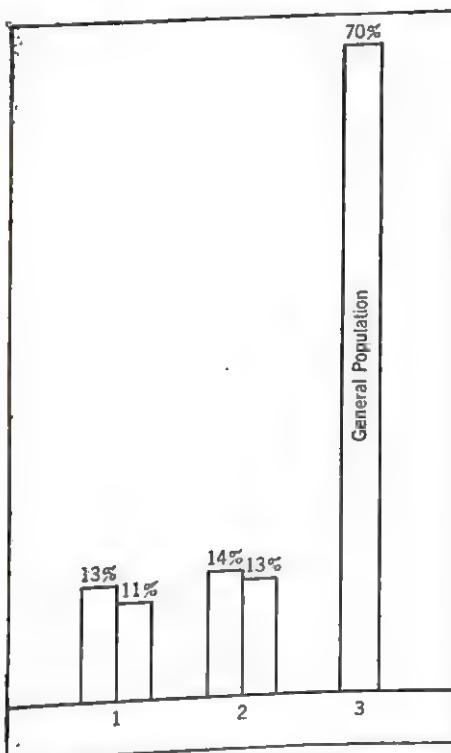


Figure 8. Percentage of Abnormal Labor Conditions in Mothers

1. Of mentally defective children (I.Q. 0-69).
2. Of retarded children (I.Q. 70+).
3. Of general population of Massachusetts (opinion of obstetricians). (From Dayton, p. 402)

those with neurological findings were usually low-grade mental defectives. The authors pointed out that only about a third of the patients who showed pyramidal or extrapyramidal lesions had a history of difficult birth. In general, histories of difficult

¹ C. A. Patten and R. A. Matthews, *Cerebral birth conditions with special reference to myelogeny*, *Archives of Neurology and Psychiatry*, 1935, 34, 61-98.

birth were as common for neurologically normal patients as for those with neurological disorders. The character of the mental defect could not be determined on the basis of the neurological defects. Somewhat similar conclusions were made by Dayton² who investigated the records of over twenty thousand retarded school children in Massachusetts. The records included social histories, physical, psychological, and psychiatric examinations, as well as the data from school tests. Dayton defined abnormal labor as prolonged, instrumental, or difficult. He estimated that abnormal labor occurs in a large percentage of the births under the care of obstetricians in the general population of Massachusetts. Nevertheless, of the cases studied, only 11 per cent of the male and 13 per cent of the female children of those with an I.Q. less than 69 had had abnormal labor conditions. Of the children with I.Q.'s over 70, between 12 and 14 per cent had abnormal labor conditions. Thus, abnormal labor did not appear to be more characteristic of the births of mental defectives than of the general population. Dayton concluded that abnormal labor was probably important in children whose I.Q.'s were below 29 and between 80 and 90, rather than in the usual types of mental defectives. The school records showed that there was no apparent relationship between the histories of abnormal labor and school accomplishment.

The importance of abnormal labor has been emphasized especially because the anatomy of the fetal cranium may be a factor in facilitating injuries. The fetal cranium is a vault of thin plates of elastic cartilage, loosely bound together by fibrous tissue and anchored to a rigid noncompressible base. These plates are easily compressible from the sides, are easily fractured, and can be made to override by unequal pressure. The dural septa play a role in protecting the fetal brain from damage due to distortion or excessive molding of the bones. The dura of the skull and spinal canal form containers for the structures and the cerebrospinal fluid. The equalized tension of the fluid prevents herniation of the brain stem into the spinal canal. The

² N. A. Dayton, Abnormal labor as an etiological factor in mental deficiency and other associated conditions: Analysis of 20,473 cases, *New England Journal of Medicine*, 1930, 203, 398-413.

elasticity of the dura and the mobility of the cranial bones allow the molding which occurs during labor. When the head presents itself abnormally, as in face, brow, occipito-posterior, and breech presentations, excessive molding and cranial distortion occur. In the occipito-posterior position, the fetal skull becomes pointed, the free edge of the falx cerebri relaxes while the middle two-thirds of the falx tightens together with the tentorium, which is also elevated. If this continues, the dural septa give way and lacerate.³ The result is a change in the balance of intracranial pressure and hemorrhage results because of the tearing of tributary veins. The change in the equilibrium of the cerebrospinal fluid pressure may herniate the medulla into the foramen magnum. In face and brow presentations, the direction of the forces is different. The anteroposterior diameter of the cranium becomes increased and the vertical diameter is correspondingly decreased. There is tension on the free edge of the falx cerebri and the tentorium. The remaining part of the falx becomes slack. The result may be rupture of the free edge of the falx and laceration of the anteroposterior set of fibers. In a breech presentation there is little time for physiological molding of the head. There may be an actual increase in anteroposterior diameter with subsequent laceration of the free edge of the falx cerebri or tentorium. The cerebrospinal fluid pressure may be unbalanced and herniation of the medulla may occur. In a contracted pelvis or when there is a relative disproportion between the size of the fetal head and the pelvis, overlapping of the fetal cranial bones may occur instead of the normal molding. The cranial distortion may become sufficient to result in the tearing of the dura from the bones and the tearing of the venous sinuses. Such an injury usually results in gross hemorrhage.

There has been a good deal of controversy regarding the effect of the molding of the head. Gynecologists generally consider seriously a condition in which there is unusual molding or distortion. Neurologists, on the other hand, have pointed out that the structure of the cranium and its contents are such that

³ See E. C. Hughes, Intracranial birth injuries, *American Journal of Obstetrics and Gynecology*, 1932, 24, 27-40.

the most unusual molding may occur without basic injury. It has also been pointed out that the usual injuries are very superficial and do not involve the cerebral hemispheres. Since the molding is generally a relatively slow process and occurs as an adjustmental structural reaction, it cannot be considered pathological. Furthermore, there has been no evidence to show that the degree of molding is related to the degree of injury.

Many conditions other than difficult labor may result in birth injuries. Birth injuries often occur in infants whose mothers have some constitutional disease. The frequency of birth injury is much greater in premature and immature infants than in normally developed infants. The premature infant is less well developed than the normal and is thus less able to resist the normal forces of labor and especially of instrumental delivery. Thus there may be a good deal of hemorrhage in premature infants whose births may appear quite normal. Gross cerebral hemorrhage and subventricular hematomas may occur in these infants in spite of relatively normal deliveries.⁴

It has been shown that slight hemorrhages may leave no after-effects, but severe hemorrhages usually result in extensive brain damage. If the infant survives, the damage will be manifested in time by mental retardation and spastic paralyses. As the result of an investigation of children, Martz⁵ concluded that punctate, or small hemorrhages, may occur without neurological defects. Those causing permanent damage are usually hemorrhages from meningeal tears or venous sinus ruptures. Hemorrhages which do not involve large areas may produce no lesions, but in some cases even moderate hemorrhages in given areas may result in cell destruction, scar formation and adhesions.

Although some neurologists have believed that intracerebral hemorrhage of the punctate type is unimportant because it usually does not result in neurological defects, psychologists have pointed out that this type of injury is sometimes much

⁴ See W. M. Hartshorn, Trauma in the newborn, *New York State Journal of Medicine*, 1937, 37, 869-877; W. E. Studdiford and H. P. Salter, The relation of labor to intracranial injury in the premature infant, *American Journal of Obstetrics and Gynecology*, 1938, 35, 215-228.

⁵ E. W. Martz, Recent trends in the problem of cerebral birth lesions, *Proceedings of the American Association on Mental Deficiency*, 1933, 57, 311-331.

more important than the gross hemorrhages which result in paralyses. It is probable that the lesions resulting from gross localized hemorrhages may be compensated for by other regions of the brain which assume some of the functions of the injured part. This is in part substantiated by the evidence from the studies of the mental functions of children who show the effects of gross hemorrhages in the form of various types of paralyses. It has been found that many of these children show a normal mental development although they may be relatively retarded during infancy. In the punctate form of lesion, especially when it occurs over a large area, there may be extensive injury to the association areas. There is, therefore, no opportunity for the assumption of function by one area of the brain in compensation for an injured part, and the result may be a mental defect.

In spite of the fact that it is now known that many birth injuries are overlooked because too much attention is paid to the presence of distinct neurological disturbances, it is important not to make a diagnosis of birth injury unless there is some direct or indirect evidence. The following case of a boy of seven illustrates a common problem of differential diagnosis. Labor was prolonged and he was relatively inactive during the first few days of life. Because of the difficult labor and the lethargic condition, a diagnosis of birth injury was made. The parents first suspected that he was not developing normally when he failed to sit up at the age of nine months. He sat up at seventeen months and learned to walk at two and a half years. At the age of four he enunciated his first distinct words and by the age of seven he was as yet unable to speak in good sentences. He was not a very difficult infant and the first serious problem occurred when he began to associate with the other children at about the age of five. It was noticed that he became more and more irritable and hyperactive and his parents were unable to control him.

When he was examined he was extremely hyperactive, noisy, and destructive. His attention span was very short and he was unable to follow directions although he was not resistive. Neurological examination showed no pathology of the cranial nerves. The deep and superficial reflexes were normal and the

fundi showed normal disks. There was no localized weakness in any limb and no abnormal physical signs.

Because of the negative neurological findings and because his developmental process was constant, although extremely retarded, it was impossible to diagnose a birth injury. On intelligence tests, he showed an I.Q. of approximately 30. On the basis of the absence of neurological signs of a central nervous system lesion, a constantly low I.Q., absence of localized signs of central nervous system irritability, and a consistent hyperactivity which seemed to be related to his inability to compete with the demands made upon him, a diagnosis of primary amentia was made and he was classified as a low-grade imbecile.

The greatest danger from gross localized injuries is the resulting necrosis. It has been shown that stasis and thrombosis of sinus and internal cerebral veins may cause necrosis of the subcortical white matter by anoxemia even where hemorrhage is not demonstrable. It has also been shown that the free blood in the subarachnoidal spaces may act as an irritant which produces aseptic meningitis. The reaction may be a proliferation of the fibroblasts, scarring which results in an interference with cortical circulation, and variable degrees of arrest of cortical development. When the lesions occur in the basal ganglia, there may be muscular rigidity and chorea-athetoid disorders without impairment of intelligence.

Some clinicians believe that diffuse microscopic hemorrhages which occur as the result of birth injury may remain asymptomatic for some time and then show their effects in the resulting mental retardation. The effects of gross localized hemorrhages manifest themselves clinically and are pathologically obvious. There is little clinical evidence, however, to substantiate the belief that the punctate type of hemorrhage results in mental deficiency. There are no known clinical methods of diagnosing diffuse microscopic hemorrhages. They are usually not sufficiently serious to cause death and therefore there has been little autopsy material. Gross localized hemorrhages are also accompanied by microscopic hemorrhages in the vicinity. It is obvious, however, that the damage to the brain is due almost

entirely to the gross rather than to the diffuse microscopic bleeding.

Our present knowledge regarding cortical activity is insufficient to enable us to explain the mechanisms by which diffuse microscopic hemorrhages cause mental retardation. It is possible that extravasated blood causes an irritative reaction which results in scarring. It is probable also, that scarring may finally be responsible for an interference with normal brain development and especially nutrition.

Temporary cerebral anemia in the course of labor or immediately following delivery may produce changes in the brain. The nervous system is extremely vulnerable to anoxemia. Biochemical and pathological studies have shown that a period of no more than about ten minutes of relative cerebral anemia is sufficient to impair the cortical cells permanently. It is possible, therefore, that varying degrees of cerebral anoxemia may interfere with cortical development and thus be responsible for mental retardation. In some cases, the blood supply to the cortex is interfered with by the meningeal fibrosis due to small areas of free blood.

Hydrocephalus

The term hydrocephalus is applied to a chronic progressive disease of the brain characterized by an abnormal increase of cerebrospinal fluid, dilatation of the ventricles, increased intracranial pressure, destruction of the cerebral hemispheres, and by manifold clinical signs.

The following brief review of the anatomical and physiological factors determining the origin and circulation of the cerebrospinal fluid may simplify the description of hydrocephalus. Although there is some controversy regarding the origin of the cerebrospinal fluid, it is generally agreed that it is largely secreted by the choroid plexuses which are lodged in the cerebral ventricles. From the lateral ventricles the fluid passes through the interventricular foramina (foramina of Monro) into the third ventricle, thence by the way of the iter (Aquaduct of Sylvius) into the fourth ventricle. At the caudal end of the roof of the fourth ventricle are located the foramen of Magen-

die and the two lateral foramina Luschka. Through these pathways the fluid escapes from the fourth ventricle into the cisterna cerebello-medullaris (*cisterna magna*). Some of the fluid descends directly at the foramen magnum to the subarachnoid space of the spinal cord and into the spinal canal from the *cisterna magna*. However, the great bulk of the fluid goes to the other basal cisternae, *cisterna pontis*, and those which encircle the midbrain in the region of the *incisura tentorii*. From these channels, largely from the *cisterna interpeduncularis* and *cisterna chiasmatica*, the cerebrospinal fluid passes through narrow pathways and floods the subarachnoid spaces of the cerebral hemispheres, whence it is absorbed into the blood stream.

There are several hypotheses regarding the method of absorption of the cerebrospinal fluid: for example, by way of the Pachionian granulations (Key and Retzius); by filtration through the villi into the dural sinuses (Weed); direct absorption by the capillaries of the whole subarachnoid space (Dandy and Blackfan). Irrespective of the mode of drainage it is definitely known that the escape of the cerebrospinal fluid into the venous circulation is from the subarachnoid space and that none or only an insignificant amount is absorbed in the ventricular system.

Types of Hydrocephalus

Hydrocephalus is usually classified as external and internal. The term *external hydrocephalus* is applied to a number of pathological phenomena of various origins. It is usually due to a cerebral defect which is congenital or due to acquired cerebral diseases and injuries. The fluid fills a vacant space which is normally occupied by cerebral tissue. External hydrocephalus is usually not accompanied by a ventricular dilatation and, as a rule, it does not produce great intracranial pressure.

Internal hydrocephalus, the most frequent type, is characterized by the pathological increase of the cerebrospinal fluid, causing dilatation of the ventricular system. It is produced by an obstruction at some point in the cerebrospinal fluid pathways. There are two types—the obstructive internal and the communicating. In the obstructive type the site of the occlusion is

in the ventricular pathways, and prevents the escape of the cerebrospinal fluid from the ventricles to the subarachnoid space.

In the communicating type of internal hydrocephalus, adhesions at the base of the brain obliterate the cisterns—mainly the ventral cistern and those around the *incisura tentorii*, which encircle the mesencephalon. The pathways of the ventricular



Figure 9. Marked Internal Hydrocephalus
(Courtesy, Dr. Meyer A. Perlstein)

system and the spinal subarachnoid space, from the foramen magnum down, usually show no anatomical changes. The communication between the ventricles and the spinal subarachnoid space is free from obstruction. However, due to the obliteration of the basal cisterns, the cerebrospinal fluid cannot reach the main field of absorption—the subarachnoid of the cerebral hemispheres—and instead is dammed back into the cavities and dilates the whole ventricular system.

Thus, in both types of internal hydrocephalus, communication is blocked between the ventricles and the cerebral subarachnoid spaces. In the communicating form the communication between the ventricles and spinal canal is patent. The two types differ in that in the communicating hydrocephalus some of the cerebrospinal fluid is absorbed from the spinal subarachnoid space, whereas in the obstructive hydrocephalus the cerebrospinal fluid is blocked from reaching any part of the subarachnoid of the brain and spinal cord.

The greatest number of cases of internal hydrocephalus are congenital. Even *in utero* it may reach such a high degree that it becomes an obstetrical problem. Ordinarily, however, the disease does not become apparent and progressive until some time after birth. The origin of the congenital type of hydrocephalus has not as yet been definitely ascertained. The exceptional capacity of the fetal tissue to absorb pathological material and the modifications to which the process of fetal growth is subjected are factors which tend to obscure the morphological changes of the disease. It is generally accepted that the pathogenesis consists chiefly either of a defective "anlage" in the ventricular pathways of the brain or of a cerebral disease acquired *in utero* (most frequently meningitis). The severity of the disease varies, depending on the period of onset, duration, and focus of obstruction. In a typical case of infantile internal hydrocephalus, the head is globular and the circumference of the skull and brain is very much enlarged. The normal circumference of the newborn is about 30-40 cm. which increases to 45 cm. in the course of the first year. In the hydrocephalic infant the circumference ranges between 60 and 100 cm. In hydrocephalus the pressure averages 300-400 mm. of water, and sometimes rises to 700 mm. The cerebral ventricles are widely distended. The choroid plexus and the ependymal lining usually show atrophic changes. The distention is limited to the cavities proximal to the block.

The skull-cap is at times thinned down to a point of translucency. The fontanelles remain open and the sutures are widely separated. The convolutions are flattened and their configuration may be reduced to a point of indistinguishability. The

brain tissue is pale, and the hemispheres are stretched and thinned. The corpus callosum and the other fibrous structures are more flattened than the gray cortex. The septum pellucidum is also flattened and dislodged. The fibers are strikingly thin, and the myelin which surrounds them is scanty. The cortical cells, although less involved, are diminished in number and replaced by gaps, giving the structure the appearance of a sieve. The white matter next to the ventricles is proportionately more destroyed than the gray. The neuroglia are decreased in number. Their expansions become willowy, thus differing from those which are produced by toxic or chronic inflammatory processes. The cerebellum, particularly its tonsils and inferior lobes, is pushed toward the spinal canal and the pons and medulla are displaced.

Acquired internal hydrocephalus may be caused by various diseases. Usually it is caused by an acute or chronic basal meningitis or by a cerebral neoplasm. Formerly tuberculous meningitis was considered the most common cause of the acute type of hydrocephalus and the terms tuberculous meningitis and acute hydrocephalus were interchanged. Basal meningitis with adhesive obliterations at any point between the foramina of Magendie and Luschka and the cisterna interpeduncularis may produce a stasis of the fluid to the point of obstruction. The onset may be pre- or post-natal. Of the 19 cases reported by Penfield, the history and autopsy findings showed that in eight cases the ventricular distention apparently developed after birth, and in eleven cases the obstruction was most frequently caused by an adhesive obliteration of the basal cisterna.

Diagnosis of Hydrocephalus

The well-developed hydrocephalic condition can be recognized quite easily. In some cases, however, an hydrocephalic infant develops relatively normally for some months and occasionally up to one or two years of age. During this period there are relatively few clinical signs except for the enlarged head. Generally, at about one year of age the progressing pathology becomes overtly manifest and a differential diagnosis can be

made with relative ease. The unusual size of the head and the motor disturbances are the outstanding early signs of hydrocephalus. The head is not only enlarged but also assumes a pearlike shape and bulges at the forehead and above the ears. Definite changes also appear in the contour of the face. The frontal bosses become prominent and there is also some protrusion of the eyeballs. The fontanelles are usually enlarged because of the separation of the sutures.

It is not an easy task, however, to make a diagnosis of arrested hydrocephalus. One of the important conditions from which hydrocephalus must be differentiated is an atrophy of the brain with the consequent accumulation of fluid.

The difficulty of such a differential diagnosis was illustrated in the case of a seven-year-old boy who first came to the attention of a pediatrician at the age of seven months. At that time the pediatrician made a diagnosis of nonsuppurative encephalitis. The infant was well nourished, able to sit up alone, not attentive to surroundings, and frequently fell forward. He was also extremely irritable, was not able to sleep well, and was hypersensitive to handling. Encephalography two years later showed a defect in the right cortex and moderate internal hydrocephalus. Repeated spinal drainage was done and the child seemed to improve. When he began to walk the pediatrician noticed there was a decided weakness and a dragging of the left leg. The weakness of the left side decreased as he became older. Severe behavior disturbances began to occur when he was about four. He developed an intense restlessness and hyperactivity. He was also extremely irritable and had many temper tantrums. Because of his behavior and because his speech development did not go on at the normal rate, he was not able to attend school. When he was seen at the age of seven he still showed some weakness of the left side but not to a sufficient degree to incapacitate him. His speech was poorly developed, and he spoke only in words and in short phrases. The spinal fluid showed a clear colorless fluid under a pressure of 26 mm. of mercury, the cell count was 5, and the Pandy was negative. The neurological examination showed hyperactive reflexes and some indication of intracranial pressure.

In this case the diagnosis was atrophy of the brain with accumulation of fluid resulting in increased pressure. The fact that the cerebrospinal fluid was easily obtained by spinal puncture, and at times under increased pressure, indicated that this was not a case of obstructive hydrocephalus. The repeated spinal drainage improved his behavior for several days at a time, but it was noticed that his symptoms returned even more acutely several days after spinal drainage.

The hydrocephalic infant shows many psychological and physical disturbances. Sensori-motor development is seriously retarded. The child is slow in his motor responses. He usually cannot balance his head well and cannot sit up or stand as the normal child. Vision is also frequently impaired early in the hydrocephalic condition. With increasing cortical damage spasticity develops. In a relatively short time the infant may pass through the stages of lethargy and somnolence to coma. At this point many convulsions may occur. In the progressive hydrocephalic condition death usually occurs within the first two or three years.

Many behavioral changes occur during the progress of the disease. The hydrocephalic child is usually irritable and his sleep and food habits are seriously disturbed. Parents report that their hydrocephalic infants are unable to take sufficient food. In some cases the pathological process ceases spontaneously, and the infants develop relatively normally. The children who survive the hydrocephalic condition improve relatively rapidly, but in most cases show some mental retardation. Nearly always, however, some psychological disorder takes place. The psychological disorder manifests itself mainly in irritability, restlessness, and emotional disturbances. In many cases these disorders do not become apparent until the child enters school when he is required for the first time to adjust to others and to concentrate on school tasks.

The effect of arrested hydrocephalus upon the behavior of a child is illustrated in the following case of a boy of eight. The boy weighed nine pounds at birth, labor was extremely difficult, and delivery was made by the use of instruments. His development was slow. He walked at sixteen months and began

to talk in sentences at about three years. During the first three months of infancy he was very quiet and the mother reported that he slept most of the time. At about the age of three, the parents noticed that he was extremely active and restless. He cried frequently and had severe temper tantrums when thwarted. The first serious behavior problem occurred when he began to attend a nursery school at the age of three. The teachers noticed that he was unable to concentrate upon even the simplest activities. He was hyperactive, irritable, and destructive. At the age of six he entered first grade but he was unable to accomplish much because of his inability to attend to the teacher's directions and because of his hyperactivity. According to his teacher, his rapid speaking was compulsive. He repeated the first grade but even during the second year he was unable to learn adequately. At the age of eight he was transferred to a special school where individual attention was given him. The teacher there reported that when she worked with him individually, without the distractions of other children, he was able to learn rapidly. When with other children, however, he became hyperactive and excitable. The neurological examination showed hyperactive superficial reflexes. There were no specific sensory or motor disturbances. The head circumference was 54.5 cms. On the basis of intelligence tests he showed an I.Q. of 85. Repeated tests showed only the ordinary test fluctuation. He was treated by placing him in an environment in which there were few distractions and where his schooling could be conducted on an individual basis. He was also given sedatives. His behavior disturbances decreased markedly and his irritability was reduced considerably after a period of three months.

There is no effective therapy for hydrocephalus. Many hydrocephalics have been treated by frequent drainage of the cerebrospinal fluid. This method is usually ineffective because the fluid is rapidly re-formed and the excessive pressure usually returns within 24 to 36 hours. Many radical procedures are frequently employed. Of these methods, coagulation of the choroid plexus is frequently attempted in the hope that the

formation of cerebrospinal fluid will be reduced. Putnam⁶ reported favorable results in four out of five infants who were treated by this method. The four who survived the operation appeared to make normal mental progress. In other cases attempts have been made to remove the choroid plexuses, but in most of these attempts the infant died.

Microcephaly

Microcephalic defectives do not constitute a large percentage of the mentally defective children. Microcephaly is a distinct type of mental deficiency, based primarily upon structural mal-development. In microcephaly there is a reduction in brain volume, especially of the cerebral hemispheres, a small and frequently maldeveloped cranium, and changes in brain structure as the result of a growth disturbance.

There are numerous theories of the cause of microcephaly. In the past, it was believed to be the result of a mechanical injury during the fetal period or the result of uterine pressure which did not allow the cranium and the brain to develop normally. In recent years the embryological basis of microcephaly has been emphasized. This theory assumes a germ cell injury but it is not known whether there is a single or whether there are multiple causative factors. According to Greenfield and Wolfsohn,⁷ the pathogenesis probably originates in two groups of factors: (1) a toxic basis, such as alcoholism of parents or metabolic toxins, acting on germ cells before conception; (2) a general pathological basis such as meningitis or encephalitis during the fetal period. According to these authors, practically all such brains show an arrest of cerebral development corresponding to the fourth or fifth fetal month.

There is some evidence to show that microcephaly may also be the result of extrinsic factors. The effects of radium or

⁶ T. J. Putnam, Mentality of infants relieved of hydrocephalus by coagulation of choroid plexuses, *American Journal of Diseases of Children*, 1938, 55, 990-999.
⁷ J. G. Greenfield and J. M. Wolfsohn, Microcephalia vera, *Archives of Neurology and Psychiatry*, 1935, 33, 1296-1316.

X-ray radiation have been studied by Goldstein and Murphy.⁸ They examined the records of 106 women treated by pelvic irradiation during pregnancy. Of these, 74 delivered full-term children. Thirty-eight of the children showed some serious defect. The most common single developmental disturbance was microcephalic idiocy of which there were 16 among the 38 children. In a later publication Goldstein⁹ reemphasized the deleterious effect of pelvic irradiation upon fetal development. Of 76 children irradiated in utero, 20 showed marked developmental defects and 19 were microcephalic. The irradiation interfered with embryonic development, especially of the central nervous system. It is well known that embryologically the head region is the most active and most easily affected by external agents. It has been found experimentally that the immature brain of the young animal is highly sensitive to radium. The pathological changes induced in the irradiated animal were similar to the disturbance found in children who were irradiated in utero.

Irradiation by X-ray or radium is, however, only one factor. The disturbed health of the mother which necessitated irradiation may have been an important factor. As many microcephalics are born of mothers who have had no radiation therapy, radiation cannot be considered the specific cause. No one specific cause of the incomplete cranial development of microcephaly has been isolated.

Clinical Signs of Microcephaly

Clinically, the microcephalic is a mentally deficient individual with a fairly characteristic appearance. The outstanding feature is a small head, which seldom attains a circumference of 17 inches. In the microcephalic infant the circumference of the head is less than that of the chest. This relationship is normally the reverse up to about one year of age. The sutures and fontanelles are either closed at birth or close very shortly after

⁸ L. Goldstein and D. P. Murphy, Microcephalic idiocy following radium therapy for uterine cancer during pregnancy, *American Journal of Obstetrics and Gynecology*, 1929, 18, 189-195.

⁹ L. Goldstein, Radiogenic microcephaly, *Archives of Neurology and Psychiatry*, 1934, 24, 102-115.

birth. The forehead is narrow and receding and the occiput is flattened. Because of the small cranium, the face appears to be large compared to the head. There may be other physical deformities.

Psychologically, the microcephalic child shows signs of mental deficiency not distinguishable from those of other types of mentally deficient individuals. There is retardation in sitting, walking, and speech. The deficiency is usually present from birth, but in some rare instances the microcephalic may develop fairly normally up to the age of six months. The mental status of microcephalics varies, but they are generally classified psychologically in the imbecile group. The severe types may remain idiots, and the very mild may develop to the level of the moron group. The mental test data on microcephalic individuals do not show any distinct disabilities except as they are associated with the mental deficiency. In contrast with the hydrocephalic children, microcephalics do not deteriorate except in rare instances. They are essentially aments whose mental development progresses at an exceedingly slow rate, and levels off at a much earlier age than in normal children. With proper training the microcephalic child or adult may be able to adjust himself relatively well to simple conditions and tasks. They nearly always remain socially helpless, however, and must be under constant supervision and guidance. Microcephalics who are institutionalized are frequently irritable, excitable, and generally hyperactive. The restlessness, however, cannot be explained in terms of the pathological defect and cannot be considered a specific manifestation of the disorder.

The general pathological characteristic of microcephaly is the hypoplasia of the brain. Grossly, the brain is smaller, and it may be asymmetrical. The occipital and parietal lobes are frequently underdeveloped as are the hemispheres generally. The cerebellum, however, is usually normal. Arrested development has also been demonstrated microscopically. Pathologists have reported that the architectonics of the hemispheres correspond to an embryonic phase approximating that of a four-month fetal brain. The exterior layers show a diminution of cells and other layers contain neuroblasts. The basal ganglia are also

cytologically and architecturally defective. In about 15 per cent of the cases hydrocephaly and porencephaly exist.

Epidemic Encephalitis

Epidemic encephalitis is an acute infectious disease of the brain probably due to a filterable virus. One of the prominent symptoms of the disease is a drowsiness or lethargy, because of which von Economo gave it the name "encephalitis lethargica." Epidemic encephalitis is important from the psychiatric standpoint, especially because of the various emotional and intellectual disturbances which frequently follow recovery from the acute illness.

The pathology¹⁰ shows ectodermal and mesodermal tissue changes of the brain, including the meninges. The meshes of the pia may be distended and contain blood cells. The congested blood vessels may be surrounded by fibroblasts, polyblasts, and macrophages. The subjacent cortex is also infiltrated, but the vascular changes are not as great. In the subcortical areas, however, the vascular changes are more pronounced, especially around the smaller veins. The perivascular infiltrations are especially prominent in the substantia nigra, around the Sylvian aqueduct, and in the optic thalamus. Many cells undergo significant changes. This is especially true of the subcortical areas.

The sequelae of epidemic encephalitis are numerous. Their occurrence and manifestations are not directly related to the severity of the acute illness. Many persons who have only a mild encephalitis, which may be described at the time as an attack of "grippe," may have serious sequelae later. On the other hand, a very acute encephalitis may result in few or no sequelae. The after-effects appear some time after the acute attack, frequently after two or three years. The physical disturbances may take the form of a Parkinsonian type of muscular change, oculogyric crises, and various forms of paresis. The mental changes may vary from mild to acute emotional and personality disturbances and various degrees of intellectual changes.

¹⁰ See G. B. Hassin, *Histopathology of the peripheral and central nervous systems*, 1933, Baltimore, The Williams & Wilkins Co., pp. 197-202.



Figure 10. Encephalogram Showing Extensive Cortical Atrophy Following Encephalitis
(Courtesy, Dr. Abraham Levinson)

The mental changes do not correlate with the physical. Persons who have many motor disturbances may show no mental changes, whereas a person without any motor defects may have serious mental changes.

Mental Symptoms of Post-Encephalitis

The mental symptoms of the post-encephalitic may be classified as subacute and chronic. In five of 174 patients studied by Cooper¹¹ there was confusional behavior with hallucinations. A number of others showed asocial behavior and psychotic disturbances. Depression was observed in 98 cases. Ten patients developed epileptoid seizures. The chronic type is characterized by bradyphrenia, such as difficulty in thinking, apathy, inertia, and restriction of interests.

Amentia does not necessarily follow encephalitis. There are no adequate data on the frequency of mental changes following epidemic encephalitis. This may be due to the difficulty of diagnosis, that is, a patient may have encephalitis but may show no physical changes following the attack. In spite of many mental changes a diagnosis of encephalitis may not be made. When mental changes occur, they usually take the form of emotional disturbances, deterioration of memory and of general intelligence, and attention disorders. A large proportion of the children who are encephalitic become mentally deficient. According to Barker,¹² all the grades of mental deficiency occur, from idiocy to slight backwardness. Memory disturbances occur, similar to the type resulting from senile dementia, that is, a failure of memory for recent events to a much greater extent than for past events. Unfortunately, many of the conclusions regarding mental deterioration are the result of indirect evidence. For example, many children become socially maladjusted and emotionally disturbed and for these reasons fail in their school studies. The school failures are often interpreted in

¹¹ H. A. Cooper, The mental sequelae of chronic epidemic encephalitis and their prognosis, *Lancet*, 1936, 2, 677-679.

¹² L. F. Barker, The sequela of epidemic encephalitis, *New York State Journal of Medicine*, 1922, 22, 251-256.

terms of an intellectual deterioration. In other instances the physical defects result in maladjustments, such as inability to write well or slowness in responding to questions. In a large number of cases the physical sequelae are in the form of muscular rigidities. For this reason one of the typical features is the masklike expression and prominent eyes. These rigidities do not allow the children to respond quickly and hence they are often thought to have deteriorated intellectually.

In many ways the emotional behavior also shows a type of rigidity which is probably similar to the muscular rigidity. The emotional responses are slow, but when they do occur, last for a much longer period than in the normal person. The individual is unable to control his emotional reactions and thus is likely to respond with extreme anger on slight provocation. Indeed, the behavior disturbances, especially of the emotional and aggressive types, are so serious that special institutions have been formed to take care of post-encephalitic children. Many children are so quarrelsome and show such strong temper tantrums that they cannot be cared for in an ordinary school or institution.

It has been shown that the intellectual deterioration is related not to the seriousness of the encephalitic attack or the physical sequelae¹³ but principally to the age of the patient. Generally, children below four or five show deterioration following epidemic encephalitis whereas children above the age of six or seven frequently show little intellectual impairment except in cases in which progressive motor disturbances occur. The adjustental ability of the post-encephalitic is frequently disturbed, especially because of changes in emotional behavior and the personality disturbances. Examinations by intelligence tests have shown that in spite of the many emotional and personality changes the intelligence level is not impaired in many children whose illness occurred after the age of six or seven.¹⁴

¹³ There is no attempt in this discussion to describe the many and varied physical sequelae. The interested reader can easily obtain this information in standard texts on clinical neurology.

¹⁴ M. Sherman and B. I. Beverly, The factor of deterioration in children showing behavior difficulties after epidemic encephalitis, *Archives of Neurology and Psychiatry*, 1923, 10, 329-343.

Syphilis

Investigators have tended either to minimize or exaggerate the relationship between congenital syphilis and mental deficiency. Juvenile syphilis has generally been considered much more serious than luetic conditions of adults. This was partly due to the recognition of the importance of central nervous system diseases in producing alterations of mental growth. It is now known, however, that a luetic condition may exist for a long time in children as in adults without affecting their mental condition.

Until recently, the incidence of luetic conditions in children has not been investigated thoroughly. In 1930 Woodall¹⁵ reported on the incidence at the Fernald State School at Waverly. On the basis of serological and clinical findings in 1,314 cases, a positive diagnosis was made in 6.5 per cent. Paddle¹⁶ found that 46 of 402 mental defectives were luetics. Potter,¹⁷ on the other hand, reported that the incidence of Wassermann-positive cases among institutional groups is only 3 to 5 per cent. He believed that the most common result of the invasion of the luetic infection into the nervous system in childhood is a mental deficiency rather than a psychotic condition. When the central nervous system is involved early in life, mental growth is usually interfered with and the result is a mental deficiency. Dayton's¹⁸ data agree with those of Potter regarding the incidence of positive Wassermann reactions. Of 9,183 mental defectives, 497, or 5.4 per cent, gave a positive reaction. Of 16,156 nondefective children, 699, or 4.3 per cent, showed a positive Wassermann. On the basis of this comparison Dayton concluded that congenital lues is not of great importance as a causative factor of mental deficiency. An analysis of 60 cases who had a positive Wassermann show that in 50 per cent of the cases other factors

¹⁵ C. S. Woodall, The incidence of congenital syphilis in an institution for the feeble-minded, *American Journal of Psychiatry*, 1930, 9, 1065-1079.

¹⁶ K. C. L. Paddle, Congenital syphilis in low-grade mentally defective children, *British Journal of Children's Diseases*, 1933, 30, 249-261.

¹⁷ H. W. Potter, Hypoprenia as a symptom of juvenile paresis, *Psychiatric Quarterly*, 1931, 5, 39-44.

¹⁸ N. A. Dayton, Congenital syphilis as a cause of mental deficiency, *Boston Medical and Surgical Journal*, 1925, 193, 668-673.

existed which might have been the basis of the mental deficiency. Dayton pointed out that the presence of a positive Wassermann does not mean that the deficiency is caused by the luetic condition.

The effect of syphilis in producing mental deficiency among adults has also been investigated. Paddle¹⁹ found that 106 showed a positive Wassermann reaction among 1,598 adult mental defectives. Of these, 75 were considered to be congenital luetics. Paddle found that the incidence was higher among the imbeciles than the idiots or morons.

TABLE 11
RELATIVE INCIDENCE OF SYPHILIS
(According to Paddle)

	Free from Congenital Syphilis		Congenital Syphilis	
	Number	Per Cent	Number	Per Cent
Idiot	135	8.9	3	3.9
Imbecile				
Low	560	36.8	31	39.7
Medium	392	25.8	23	29.4
High	151	9.9	10	12.9
Feeble-minded	282	18.6	11	14.1
Totals	1,520	100.0	78	100.0

The luetic condition which is most important in the development of mental deficiency is general paresis. It has been estimated that between 1.5 and 2 per cent of children with congenital lues develop general paresis. In many of these cases the initial sign is a disturbance of intelligence with a progressive deterioration. The physical signs, such as cranial nerve palsies, optic atrophy, and in some instances hemiplegia, develop progressively. It is generally believed that these focal signs are more frequent in the juvenile than in the adult type of paresis, possibly because the juvenile form has both meningo-vascular and parenchymatous involvement of the brain. In many cases

¹⁹ K. C. L. Paddle, Congenital syphilis in mental defective adults, *Journal of Neurology and Psychopathology*, 1934, 15, 147-159.

the mental deficiency is not progressive. In others, the I.Q. may be constant for some time and then show a sudden decrease. Menninger²⁰ reported that 40 per cent of 426 cases of juvenile paresis were mentally retarded. They were mentally deficient before other significant signs and symptoms appeared. Sixty per cent of the cases developed normally until the onset of the disease. Menninger stated that the typical mental picture is one of confusion, inadequate emotional response, restlessness, and mental regression. The feeble-minded persons in whom the disease develops rarely show well-developed delusions.

The degree and process of intellectual deterioration of adult paretics have not been adequately studied. This is due principally to the fact that the psychotic condition usually interferes with an adequate testing procedure. The adult paretic shows definite signs of progressive deterioration, but whether the deterioration is wholly intellectual or whether it is in part related to the confusion and other psychotic symptoms is not known. The behavior of the advanced paretic is of the dementia type, and tests have shown that deterioration probably occurs early and is continuous. The confused and disoriented behavior is in part a result of the intellectual deterioration. In addition to the confusion and the disorientation, there is a definite memory failure. The memory failure sometimes appears to be greater than the general intellectual deterioration. For example, the paretic who cannot recognize his relatives or his children and cannot remember events from one hour to another may, nevertheless, show a rating on a test on the basis of which a higher level of intellectual behavior may be expected.

The pathology of juvenile paresis does not differ greatly from that of adult acquired paresis. The destruction of the cortical areas is extensive and probably accounts for the intellectual deterioration. The pathological condition is due to actual spirochetal infiltration and is characterized by a diffuse inflammatory and degenerative condition which affects mainly the cortex. There is an extensive cellular infiltration of blood vessels and capillaries. According to Hassin, the inflammatory

²⁰ W. C. Menninger, Juvenile paresis, *Menninger Clinic Monograph Series*, No. 1, 1936, Baltimore, The Williams & Wilkins Co.

cells are confined to the Virchow-Robin spaces of the adventitia and very seldom transgress the adventitial glial membrane into the surrounding tissues. Accompanying the cortical changes



Figure 11. Congenital Lues
(Courtesy, Dr. Meyer A. Perlstein)

there may be leptomeningitis and pachymeningitis. The most extensive pathology is found in the anterior portions of the frontal and temporal lobes in the region of the operculum. According to some pathologists, the basal ganglia also show

degenerative changes and there may be gliosis in the thalamus. The putamen is usually affected, and there is common involvement of the spinal cord and cerebellum. The globus pallidus is nearly always unaffected. The frontal convolutions are frequently atrophied, the weight of the brain is decreased, and an external hydrocephalus may occur. The ventricles are often distended and the ependyma is granular. The ganglion cells of the deep cortical layers show continuous extensive degenerative changes.

Although the extent of mental deterioration roughly parallels the extent of cortical deterioration, there is no point-for-point relationship. It has been shown that after adequate treatment there is a corresponding improvement of the condition of the brain. There have been no extensive studies, however, on the relationship between the degree of neurologic "improvement" and the intellectual improvement.

Amaurotic Family Idiocy

The condition generally known as amaurotic family idiocy was originally described by Tay in 1881. In 1887 Sachs published a detailed description of a series of cases and introduced the name "amaurotic family idiocy."²¹ Since then a number of cases have been reported, sometimes under the name of Tay-Sachs disease. It has generally been agreed that the disease is familial and hereditary. It is, in a sense, one of the few types of nervous system diseases accompanied by intellectual deficiency as a prominent factor, and can be definitely traced hereditarily. According to some investigators, the disease is transmitted as a Mendelian recessive characteristic. The total number of cases reported is not sufficient, however, to warrant conclusions regarding the exact hereditary factors. The fact that it occurs in families in more than one instance and that many have been observed as the result of close consanguinous marriages indicates strongly that its recessive characteristic is significant.

²¹ B. Sachs, On arrested cerebral development with special reference to its cortical pathology, *Journal of Nervous and Mental Disease*, 1887, 14, 541-553. See also A family form of idiocy, *New York State Journal of Medicine*, 1896, 63, 697-703.

Amaurotic family idiocy can be easily defined both clinically and pathologically, and the intellectual characteristics are also specific. Three types have been observed: the infantile, the juvenile, and the adolescent. There is essentially little difference between the types except for the age of onset and the degree and rapidity of the sensori-motor and intellectual deterioration.

In the infantile type the condition is first observed at from three to six months of age. Eye disturbances occur very early but may be unrecognized for some time. There are macular changes leading to blindness, muscular weakness, and intellectual deterioration. The weakness or paresis varies from flaccidity to spasticity. Nystagmus and strabismus frequently occur and in many cases there are epileptiform convulsions. Death most often takes place at about two years of age.

The juvenile type usually occurs between the ages of five and seven, frequently after the child has developed normally physically and mentally. One of the first signs is intellectual deterioration which progresses rapidly. Loss of vision also occurs in the beginning stages and progresses into blindness. The dementia and spasticity increase in severity, and death usually takes place within five years of the onset or around twelve years of age. Clinically there is very little difference between this type and the infantile type except for the ophthalmoscopic findings of brownish pigmentary macular changes instead of a cherry red spot.

The adolescent type usually occurs between fourteen and sixteen years of age. The eye changes are similar to those of the other types except that central scotoma also occurs. The loss of muscular power is one of the chief early signs. There have been reports of cases in which retinal changes occur not accompanied by brain pathology.²²

The infantile and juvenile types are closely related and are probably the result of a basic disorder of lipoid metabolism as a consequence of a constitutional deficiency which is hereditarily determined. The retinal changes parallel the brain changes. In

²² See J. I. Gouterman, Tay-Sachs disease, *Transactions of the American Academy of Ophthalmology and Otolaryngology*, 1930, 35, 83-91.

many cases intellectual deterioration coincides with the beginning of the loss of vision. The retinal as well as muscular changes are bilateral and symmetric. Epileptic-like seizures have been reported in more than half of the cases and occur with a given degree of brain change. In the juvenile type the clinical picture is manifested at first by visual disturbances and an unusual posture and gait. The gait is usually sluggish, and the child stoops forward because of muscular impairment. As the disease progresses, there is an increasing flexion of the arms and legs. Because of increasing muscular tonicity, the child usually has difficulty when he begins to walk. In spite of the increasing muscle tonus there is frequently no tremor, athetosis, or clonus. It is usually difficult to discover sensory disturbances. In most cases there are no gross sensory disorders except for vision. Speech is usually disturbed rather early. At first it is slow and hesitating and later tends to be difficult and unintelligible. The end stage is usually marked by a loss of speech, extreme intellectual deterioration, inability to sit, stand, or walk, contractures of the limbs, and emaciation. The course of the disease is somewhat less rapid in the adolescent type. An occasional case has also been reported after the age of twenty and described as the adult type.

Pathology

A number of pathological studies have been reported. In general, the reports have agreed regarding the most important pathology. Hassin²³ stated that the characteristic feature involves especially the morphology of the ganglion cells in all types of amaurotic family idiocy. They are changed throughout the nervous system. They are usually swollen and the dendrons are frequently obliterated. The Nissl bodies are usually deficient and gather around the nucleus. The nucleus is frequently pushed to the apical dendron and the neurofibrils are misplaced. In addition to the cellular changes, the brain frequently shows a loss of substance, especially in the frontal lobes. Hassin pointed out that the condition is not only morphologic but also

²³ G. B. Hassin, Amaurotic family idiocy; clinical and pathological studies, *American Journal of Psychiatry*, 1929, 8, 969-977.

involves chemical changes. In some of the types of amaurotic family idiocy there may be more destruction in given areas, as for example in the optic thalamus, Anion's horn and the occipital lobes. In the late infantile form there are characteristic gross changes. In this form the cerebellum is atrophied, the Purkinje cells are damaged, the fibers lacking, and there is reduction of the granular layer. The occipital lobes are degenerated with special involvement of the third, fourth, and fifth cortical layers, and there is also marked atrophy of the frontal lobes.

According to Hassin, the chemical changes are far more important than the structural disturbances. This is shown by the fact that the structural changes may be alike in all types, whereas the chemical changes differ. According to some observers, the chemical changes may be due to some inherent deficiency of the vegetative mechanism of the ganglion cells. The result is a far-reaching disturbance of metabolism. This metabolic disturbance progresses, and results in structural changes. Winkelmann²⁴ agrees essentially with Hassin regarding the pathology of amaurotic family idiocy. He observed a lipoid disorganization in the cell bodies and a sclerosing process due to a proliferation of astrocytes. Additional histopathological findings were reported by Bing.²⁵ He stated that there is swelling of the intrafibrillary hyaloplasm and vacuolization. He also reported that the entire brain and cord are deficient in certain nucleoproteids. He interpreted the pathological findings in terms of a primitive cyto-architectonic structure of the cortex somewhat like that of the ape.

There is no known treatment, either psychological or medical. The diagnosis is made on the basis of the clinical findings and on the concomitant relatively rapid intellectual deterioration. Psychological therapy is of very little significance because the degree of intellectual deterioration is determined by the cortical deterioration.

²⁴ N. W. Winkelmann, Tay-Sachs disease, *Histopathology of two cases of Tay-Sachs disease*, *Transactions of the American Academy of Ophthalmology and Otolaryngology*, 1930, 35, 92-100.

²⁵ R. Bing, *Textbook of nervous diseases* (trans. by Webb Haymaker), 1939, St. Louis, Mosby & Co.

Other Organic Conditions

There are a number of relatively rare pathological brain conditions which may cause mental deficiency. As an example, Virchow's interstitial encephalitis, which is an encephalomalacia, has been described both clinically and pathologically. This condition occurs in infancy and is manifested by cerebral softening which is usually believed to be due to trauma at birth. It sometimes occurs in adults as the result of vascular lesions. Occasionally, infection may be the etiological factor. According to a description by Diamond,²⁶ the principal changes are circumscribed and diffuse collections of gitter cells and fat droplets in the white matter. Infants who survive may later show convulsions, paralysis, spasticity, athetosis, and low-grade mental deficiency.

Another rare condition is the Lawrence-Biedl syndrome.²⁷ Obesity and feminine characteristics in boys are commonly the external signs. In girls maturation is delayed. Polydactylism or syndactylism is almost invariably present, and visual defects are frequent. Another rare condition is gargoyleism. Up to 1936, according to Ellis²⁸ and his co-workers, only ten cases were reported. According to these authors, the features are skull deformities, such as scapocephaly and acrocephaly, kyphosis and flaring of the lower ribs, the late appearance of ossification centers, corneal opacities, and enlargement of liver and spleen. All of the children described were mentally defective. In some instances the regression occurred after the second year.

The growth and metabolic disturbances are probably the causes of the mental deficiency of patients with Fröhlich's syndrome. On the other hand, there have been reports that such patients may be not only of normal intelligence but also superior. Schott,²⁹ for example, reported on seven patients diagnosed as

²⁶ I. B. Diamond, Encephalomalacia in infants, *Archives of Neurology and Psychiatry*, 1934, 31, 1153-1163.

²⁷ See H. G. Beck, The Lawrence-Biedl syndrome: Reports of two cases in one family; Results of treatment, *Endocrinology*, 1929, 13, 375-387.

²⁸ R. W. B. Ellis, W. Sheldon, and N. B. Capon, Gargoyleism (chondro-osteodystrophy, corneal opacities, hepatosplenomegaly, and mental deficiency), *Quarterly Journal of Medicine*, 1936, 5, 119-139.

²⁹ E. L. Schott, Superior intelligence in patients with Fröhlich's syndrome, *Journal of Applied Psychology*, 1938, 22, 395-399.



Figure 12. A Photomicrograph of Normal Brain Tissue—
The Premotor Area

The various layers of the cortex are well shown.



Figure 13. An Area from a Softened Brain
The brain tissue is broken up and the layers are distorted and invaded by connective tissue fibers. In many areas the softened tissue dropped out, leaving spaces appearing homogeneous. (Courtesy of Dr. George B. Hassin)

typical cases of Fröhlich's syndrome. He concluded that intellectual retardation is not necessarily a concomitant of a pituitary deficiency.

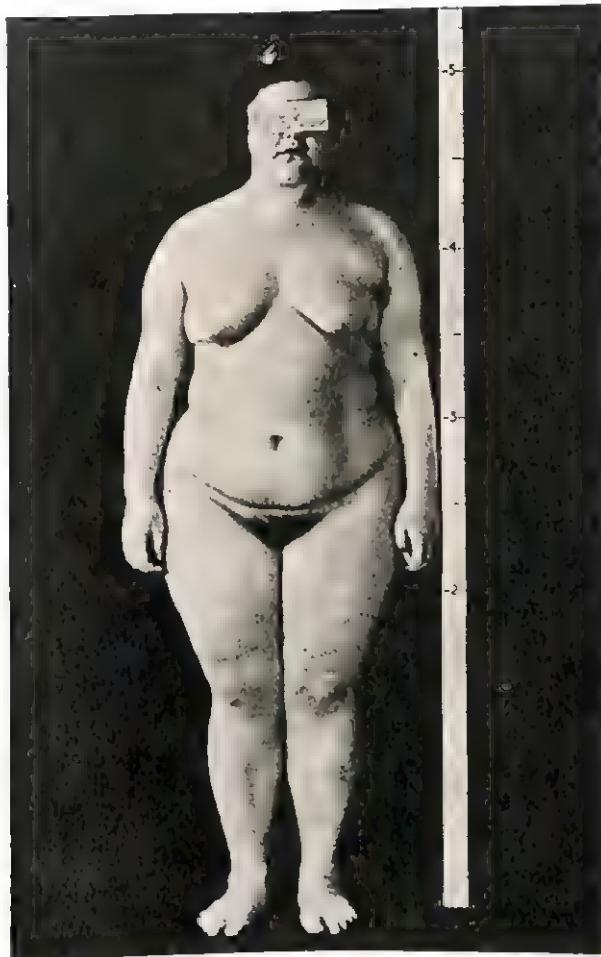


Figure 14. Fröhlich's Disease, Fourteen Years Old, Mental Deficiency
(Courtesy of Dr. I. P. Bronstein)

Aplasia exialis extracorticalis congenita is a disease manifested in the first few months of life and progresses rapidly until about six years of age. From then on, the progression is

slow and unless some intercurrent infection ends life, the patient may live for some time. The syndrome consists of nystagmus, defective speech, ataxia, intention tremors, generalized muscular weakness, muscular spasticity, hyperactive reflexes, vaso-motor and trophic disturbances, and mental retardation. The brain is small. There is a loss of myelin substance in the subcortical areas. The cortex of the cerebrum and cerebellum are intact.

Progressive subcortical degenerative encephalopathy (*encephalitis periaxialis diffusa*) is known as Schilder's disease. The clinical picture is quite variable. As reported by Schilder, the early symptoms include irritability, restlessness, intention tremors, and mental impairment. The course is progressive. Vision and hearing become defective, and convulsive seizures also appear. Further mental deterioration and total blindness develop. The condition is fatal in about three years. Globus and Strauss reported a slightly different clinical course with gastrointestinal disturbances at the onset. Later, cerebral symptoms appear which include spasticity, convulsions, blindness, deafness, aphasia, and mental deterioration. Pathologically, the brain is small with wide fissures and prominent gyri. The tissue has an increased resistance, and is almost leathery. The cortex is unaffected, but the subcortex, basal ganglia, and fibrous tracts are involved, showing widespread demyelination and diffuse gliosis.

Tuberous sclerosis is an uncommon disease resulting in mental deficiency and is classically associated with multiple tumors and epileptiform convulsions. Tumors occur in many organs including the skin where they occur as sebaceous adenomas. Multiple tumors occur in the brain where they appear on the cerebral cortex and elsewhere as hard nodules. These nodules tend to merge with the underlying subcortex and distort the laminations of the cortex and the normal cyto-architecture. In the region of a nodule there is a reduction in nerve cells and an increase in neuroglia. Atypical cell forms, large or malformed nerve cells, are irregularly distributed in the gray or adjacent white matter. The ganglion cells are markedly changed in form, size, and internal structure. Large giant cells, often three to four times the size of pyramidal cells, are characteristic. A

dense gliosis is present in the tuberous areas. The disorder appears to be due to some endogenous factor affecting the central nervous system during the formative stages. Whether this is another form of disordered development or primarily neoplastic in nature is not clear.³⁰

³⁰ See J. H. Globus, Malformation in the central nervous system, Section 27, in *Cytology and Cellular Pathology of the Nervous System*, edited by W. Penfield, 1932, New York, Paul B. Hoeber, pp. 1150-1166.

Chapter 9

EPILEPSY

The Nature of Epilepsy

Epilepsy is a disorder characterized by paroxysmal attacks of unconsciousness, involving, in some conditions, convulsions. Two general types of epilepsy are usually described, the idiopathic, in which no known organic basis has been discovered, and the organic (or symptomatic) type (Jacksonian), the basis of which is some irritation in the central nervous system such as a tumor, pressure, or meningeal irritation. Many neurologists have emphasized the fact that epilepsy cannot be called a disease entity because a large number of conditions may produce unconsciousness. Nor can the convulsions be the criterion of a disease entity. Cobb,¹ for example, listed the following mechanisms which are associated with convulsions:

1. Direct irritation
2. Congenital defect of function
3. Tissue destruction
4. Increased pressure
5. Congestion
6. Hydration
7. Dehydration
8. Vasoconstriction
9. Permeability
10. Asphyxia
11. Alkalosis

Cobb believed that most convulsions are associated with some acquired abnormality of the nervous system although an injury

¹ S. Cobb, Concerning fits, *Medical Clinics of North America*, 1936, 19, 1583-1595.

may precipitate or cause to become overt a latent tendency to convulsions. Cobb also pointed out that not only are the causes varied but the attacks also vary greatly. He emphasized the fact that the disorder is characteristically a disturbance of consciousness which occurs suddenly.

Typical epilepsy must be differentiated from other conditions such as Jacksonian epilepsy due to some irritation. It must also be differentiated from hysterical reactions. In hysteria the attacks usually occur when the seizure is witnessed by others and is the result of imitation. Loss of consciousness and convulsions may occur in major hysteria, but the patient usually does not injure himself by falling. If injuries do occur they are usually slight and are rarely repeated. The hysterical patient rarely bites his tongue, although he may appear unconscious and his behavior may appear entirely uncontrolled. The pupillary reflexes of the hysterical person are preserved during the attacks. He often assumes unnatural or posed positions during the attacks as if he were deliberately attempting to impress his audience.

Many classifications of convulsive states in children have been made. Peterman,² as a result of a study of convulsive seizures in children, presented the following classification of causes and their frequencies in his series of 500 cases:

	Per Cent
Idiopathic epilepsy	33.0
Acute infections	22.8
Cerebral birth injury or residuals	15.4
Spasmophilia or tetany	13.6
Miscellaneous group	8.8
Group in which cause is unknown	6.4

Idiopathic epilepsy is generally divided into the petit mal and the grand mal types. In petit mal there is only a momentary loss of consciousness, but in grand mal there is a definite loss of consciousness accompanied by a convulsion. The statistical studies available at present are not sufficiently accurate for an

² M. G. Peterman, Convulsions in childhood, *Journal of the American Medical Association*, 1934, 102, 1729-1732.

estimate of the frequency of petit mal. The symptoms of petit mal vary not only in type but also in intensity. In many instances the seizures, and thus the loss of consciousness, are so brief that parents do not observe them for a long period of time. In other instances the period of loss of consciousness may result in some behavior disturbance. In the case of a ten-year-old child, for example, the parents stated that they had observed that he showed momentary periods of inattention accompanied by rolling of the eyes and rigidity of the face. They recognized that there was something wrong because they tried to speak to the child during those periods, but he did not respond. They recalled that he had had such periods of loss of attention for some five years, but they were neither as frequent nor as of great duration previously.

In the case of a nine-year-old boy, the symptomatology was so obscure that a definite diagnosis was made only by the electroencephalograph. The parents brought him for examination because they suspected that he had had a birth injury and that his condition was not properly treated. The mother stated that a diagnosis of post-encephalitis was also made because of his behavior. The birth was instrumental and the mother reported that the obstetrician stated that the infant's head was abnormally large. He did not walk until he was sixteen months old, and he spoke in words at about two years. When he was three years old he entered a nursery school. He remained there about a year but his adjustment was not good. When he was seven he entered the first grade in a public school but after six months the mother was advised to remove him because he was unable to concentrate, talked incessantly, and frequently vomited. The mother stated that during the past year the child began to talk "nonsense." He frequently talked at random and answered her questions by irrelevant remarks. When the boy was six years old the parents noticed that he frequently stopped whatever he was doing, and his eyes appeared fixed for a few seconds. The parents at first believed that this was a mannerism that he had acquired from some child. During the past year he developed another symptom which worried the parents. This was a nodding of the head and a rigidity which occurred about once every

two or three days. This behavior was noticed especially when the child was walking on the street. He stopped suddenly, became rigid, stared in one direction, and in a few seconds resumed his previous activity.

Intelligence tests showed him to have an I.Q. between 70 and 75. Over a period of two years the I.Q. did not change essentially.

In this case the differential diagnosis had to be made between epilepsy, a schizophrenic condition, and a behavior aberration together with mental retardation. The irrelevant conversation that the boy often held with other children, his frequent lack of comprehension, his short attention span, his mental blocking, and the appearance of being out of contact were signs which pointed to a diagnosis of juvenile schizophrenia. On the other hand, there were indications that his training was not good and that his older brother had established a bad relationship with him. His behavior may therefore have been simply the result of poor training, and the mental retardation increased his conduct disturbance. The signs which pointed to a diagnosis of epilepsy were the periods of unconsciousness as illustrated in his rigidity and the fixation of his eyes. The fact that additional types of seizures were seen after the first seizures were reported tended to corroborate the belief that this was an epileptic condition. A specific diagnosis of epilepsy was made on the basis of electroencephalographic tracings. The tracings showed an alpha wave frequency of four per second with a number of inversions. By the use of a ketogenic diet and sedatives the frequency of the attacks was decreased and his general behavior seemed to improve. After a period of six months of treatment it was noticed that his attention span was longer and that he was able to concentrate a great deal more on his school work.

Four stages have been described in grand mal epilepsy: the prodromal symptoms, consisting of feelings of uneasiness and irritability; the aura, consisting of sensory disturbances, frequently of the gastrointestinal tract; loss of consciousness and convulsions; and the final period of deep sleep. The intensity and duration of these stages are related in many ways to the

duration of the disease, and are factors in the subsequent personality and intellectual changes.

The most extensive studies of epilepsy have been made of institutional cases. Only about 5 per cent of all epileptics are institutionalized. They are frequently sent to an institution during late adolescence or adulthood and only after deterioration has taken place either in their personalities or their intelligence. A survey³ made in 1936 showed that 16,641 epileptic patients were in institutions for mental defectives. A number of epileptics are also found in institutions for the mentally abnormal. The majority of epileptics are able to maintain themselves outside of institutions, especially when they undergo some systematic treatment. A report of McGhie and Myers⁴ showed that only 1,000 of an estimated 7,000 epileptics in Ontario were in institutions. They estimated the rate of epilepsy as two in every thousand population. In a series of 937 cases which were seen clinically, 10 per cent were of preschool age and 50 per cent were of school age. Many of the children were excluded from school because of their seizures.

The social significance of epilepsy has been emphasized not only by neurologists but also by psychologists. Even when the seizures occur only occasionally, the epileptic is often likely to be socially ostracized because an epileptic seizure is peculiarly offensive to most people. The occurrence of the seizures varies in different cases. In some they occur only diurnally, and in others, nocturnally. Some epileptics have attacks during both day and night. It has been estimated that 45 per cent of the seizures occur diurnally, and the nocturnal type occurs with the least frequency. The interval between attacks is longest in the diurnal group.

The literature contains a great deal of discussion of the possible causes of idiopathic epilepsy. Some neurologists believe that epileptic patients have a primary physiological disturbance, and the convulsions or other symptoms are the result of external causes which may have no effect upon normal persons. Others

³ Mental defectives and epileptics in institutions, 1936, 1938, Washington, D. C., Government Printing Office.

⁴ B. T. McGhie and C. R. Myers, A public health approach to the problem of convulsive disorders, *American Journal of Psychiatry*, 1939, 95, 1077-1082.

maintain that the epileptic inherits a specific tendency to the disease. Stein⁵ reported on a study of 1,000 patients from a state hospital for epileptics in which the factors of the frequency of the seizures and the family history were studied. A control group of nonepileptic individuals was also studied by means of a questionnaire. Seizures were reported in at least one member of the immediate family in over 18 per cent of the epileptics and in only 4.6 per cent of the control group. Thus, in 82 per cent of the epileptics there were no seizures in any member of the immediate family. Neurologists have criticized studies of epileptics in which histories of the families are obtained. They have pointed out that the statistical accuracy of the evidence based on information from patients or their relatives should be seriously questioned. It has been shown, for example, that epileptics are peculiarly sensitive to the occurrence of epileptic

TABLE 12
INCIDENCE OF EPILEPSY IN TWINS
(From Rosanoff, Handy and Rosanoff)

Type of Twins	Number of Cases	One Affected	Both Affected
Monozygotic, male	9	4	5
Monozygotic, female	14	5	9
Same sex, dizygotic, males.....	15	12	3
Same sex, dizygotic, females.....	24	20	4
Opposite sex, dizygotic.....	45	32	13
Totals	107	73	34

conditions in other members of their families, whereas persons who are free from epilepsy may not be as aware of their family histories. Many other surveys have been reported of the incidence of epilepsy and allied conditions in families. The hereditary factors cannot be clearly evaluated from such studies, however. Studies of twins have been made especially because the hereditary factor can be evaluated more carefully than in other

⁵ C. Stein, Hereditary factors in epilepsy, *American Journal of Psychiatry*, 1933, 12, 989-1037.

types of studies. Rosanoff and Handy⁶ made a study of 23 pairs of monozygotic twins, 39 pairs of dizygotic twins of the same sex, and 45 dizygotic of the opposite sex. On the one hand, they found that the hereditary factor is indicated by the greater proportion of the other twin showing epilepsy in monozygotic pairs than in the dizygotic. On the other hand, in many cases only one twin of a monozygotic pair was affected. Epilepsy was much more common in the other twin of dizygotic pairs than among ordinary siblings. Rosanoff and Handy found a large number of associated conditions such as psychotic and neurotic disorders, and they concluded that epilepsy cannot be regarded as functional or idiopathic but rather as a definite organic deterioration syndrome.

Age of Onset

The age of onset of epilepsy varies. The age at which the attacks first occur has been considered an important factor in determining personality and intellectual changes. According to some reports, one-eighth of the epileptics begin to have their attacks between the ages of one and three, and 75 per cent between twelve and twenty. When the epileptic condition is manifested early in life there is a greater probability of physical and intellectual deterioration than when it first occurs during or after adolescence. Some cases have been reported, however, in which early epilepsy has disappeared when the child reaches the adolescent period. A form of epilepsy known as pyknolepsy has been described in which petit mal attacks are observed between the ages of four and twelve, but they are infrequent, do not interfere with mental and physical development, and disappear spontaneously. Another form of epilepsy which does not cause mental or physical symptoms is known as idiopathic narcolepsy in which the attacks consist of sleep or trancelike states. In some cases the attacks simulate a cataleptic condition.

The importance of the age of onset of the seizures has been pointed out in studies comparing institutionalized and noninsti-

⁶ A. J. Rosanoff, L. M. Handy, and I. A. Rosanoff, Etiology of epilepsy with special reference to its occurrence in twins, *Archives of Neurology and Psychiatry*, 1934, 31, 1165-1193.

tutionalized patients. Lennox and Cobb⁷ reported that for institutionalized patients the peak ages of the onset are under five years. Of the noninstitutionalized cases, only 14 per cent showed attacks before the age of five, and the peak age for onset

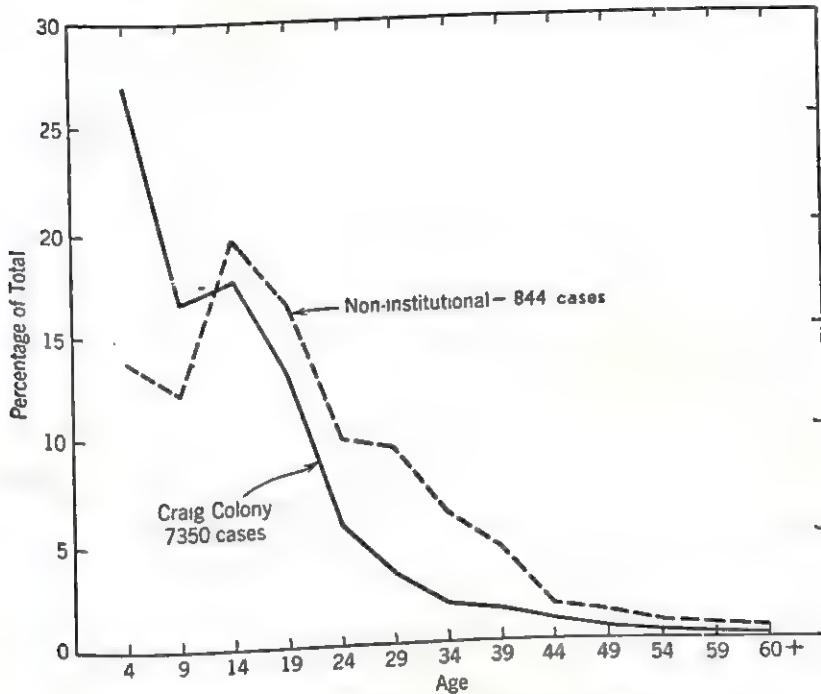


Figure 15. Age of Patients at Onset of Seizures

This chart shows the age of onset of seizures of 7,350 patients at Craig Colony compared with 844 noninstitutionalized patients. (From Lennox and Cobb, p. 359)

was from ten to fifteen years of age. Of the patients entering the Craig Colony only 14 per cent were mentally normal whereas of the noninstitutionalized patients 65 per cent were normal.

As stated previously, the etiology of idiopathic epilepsy is unknown. The evidence for its hereditary basis is very scant, and no specific neurological or pathological conditions have been

⁷ W. G. Lennox and S. Cobb, The noninstitutional epileptic, Epilepsy and the convulsive state, 1931, Baltimore, Association for Research in Nervous and Mental Disease, pp. 358-372.

universally observed. The cause of a given attack varies from case to case. The influence of emotional conditions and emotional traumas has been emphasized by many psychiatrists. Ample evidence has been found to show that a given attack may be caused by an emotional disturbance, but there is little evidence to show that the emotionality of an individual determines the epileptic pattern. Exaggerated importance has at times been attached to the psychological findings. Some psychiatrists have assumed that because epilepsy is characterized by loss of consciousness it represents a process of escape from reality which may not be possible otherwise. Carlisle,⁸ for example, stated that idiopathic epilepsy is a particular and specific way of reacting to the reality of life, that is, by convulsions or convulsive equivalents. The convulsive state thus represents a complete escape. Similarly, others have attempted to explain the epileptic conditions in adolescence and climacterium as evidence of retreat from unbearable problems. In these instances the epileptic condition supposedly represented a regression.

The influence of emotion as a precipitating factor in some attacks has been shown by a number of investigators. Fremont-Smith⁹ studied 42 unselected private patients with convulsions and found that in 31 cases a direct relationship existed between an emotional disturbance and at least one major convolution. In a number of cases the attacks were preceded by some strong emotion. Anger episodes, for example, have been observed to be a common precipitating cause. It is not known whether the anger is the basis of the attacks or whether the anger reactions represented the prodromal symptom. Anger supposedly causes a greater excitability of the central nervous system and thus aids in producing the sudden nervous activity which results in the loss of consciousness and the convolution.¹⁰

⁸ C. L. Carlisle, The etiology of idiopathic (non-organic) epilepsy, *United States Veterans' Bureau Medical Bulletin*, 1929, 5, 161-173.

⁹ F. Fremont-Smith, The influence of emotion in precipitating convulsions, *American Journal of Psychiatry*, 1934, 13, 717-723.

¹⁰ A conclusion reached by those who seek for psychogenic origins is illustrated in a report by R. C. Hamill, Petit mal in children, *American Journal of Psychiatry*, 1936, 83, 303-312. He stated that in all the cases of children that he has been able to study the emotional element seemed to have its psychogenic source in ideas of eating and was closely related to oral impregnation. Thus, oral attacks on parents, especially fathers, were important factors. The unconsciousness supposedly masked the unacceptable emotional elements which the children had to face.

Personality Changes

Personality changes have been reported by a number of investigators. These personality changes frequently occur after a relatively long period of convulsions. The question naturally arises as to whether the personality changes are the result of the convulsions or whether the personalities of epileptics are basically different from those of nonepileptics. The personality of the epileptic has been considered by some psychiatrists to influence the form which the symptoms assume. For example, Diethelm¹¹ reported that convulsions and fugues are common in poorly organized personalities. Diethelm believed that personality factors must be evaluated in relation to each individual and each attack. Others have reported that personality disorders are important not only in affecting the type of attack but also as a direct cause of epilepsy. Notkin¹² reported cases of hysteroepilepsy in which the hysterical manifestations finally developed into typical symptoms of epilepsy. In an earlier article Notkin stated that the peculiarities of the personality of the epileptic are the result of the epileptic reaction and not its cause. He also stated that it appears unwarranted to speak of an epileptic type of personality.¹³ This view is shared by Doolittle,¹⁴ who emphasized that epilepsy can be superimposed upon any type of personality as can any other disease. Doolittle believed that the personality of the epileptic depends upon the age of onset. An epileptic in whom the onset occurs under fifteen or sixteen years of age is shunned by his playmates and by adults, and shielded at home. Thus his interests become directed toward himself and childish personality traits tend to persist. In those in whom the onset is twenty to forty years of age the personality has already developed, but even during these ages the necessary social readjustment may result in personality disorders.

¹¹ O. Diethelm, Epileptic convulsions and the personality setting, *Archives of Neurology and Psychiatry*, 1934, 31, 755-767.

¹² J. Notkin, "Affectepilepsy" and "hysteroepilepsy," a study of convulsive states in psychopaths, *Journal of Nervous and Mental Disease*, 1930, 72, 135-153; 266-280.

¹³ J. Notkin, Is there an epileptic personality makeup? *Archives of Neurology and Psychiatry*, 1928, 20, 799-803.

¹⁴ G. J. Doolittle, The epileptic personality, its progressive changes among institutional cases, *Psychiatric Quarterly*, 1932, 6, 89-96.

Careful studies of the developmental histories of epileptic patients have given increasing evidence that many of the personality characteristics which are usually described as epileptic in origin are the result of the difficulties inherent in the social aspects of the disease.¹⁵ Epileptic patients recognize the unfavorable attitudes toward them. They are excluded from most vocations, segregated in the schools, and ostracized socially. They perhaps naturally become self-centered because of their social isolation. They also frequently resent the care and protection which they necessarily must have. The kinds of personality deviations of epileptic patients are determined in part by the ways in which they are treated and the care which they receive.

Some of the personality characteristics of the epileptic child may be the direct result of the disease process. Anger and irritability may be substitutive reactions. They may be epileptic equivalents. Observation of a number of children who had no previous specific epileptic attacks (at the Orthogenic School, The University of Chicago) showed that the usual epileptic attacks were frequently preceded by cyclic periods of intense anger and irritability. A child of six, for example, had several convulsions during infancy but did not have any attacks after the age of two. The parents reported that she had peculiar spells consisting of irritability, argumentativeness, aggressive and destructive behavior, and temper tantrums. These periods occurred every two or three weeks and lasted for three or four hours. The electroencephalogram showed typical epileptic brain waves. No epileptic seizures occurred during the first four weeks of observation. During the second week of observation brief petit mal attacks were observed. They manifested themselves in momentary rigidity of the face and turning of the eyes accompanied by flushing and unresponsiveness. The cyclic occurrences of anger lasted for two months and then disappeared. About two weeks later a typical major seizure was observed during the night. This case may be interpreted as one in which the epileptic condition existed from early infancy, but the actual

¹⁵ See E. M. Bridge, Mental state of the epileptic patient, *Archives of Neurology and Psychiatry*, 1934, 32, 723-736.

epileptic attacks were substituted by the anger and irritability equivalents.

The manifestation of epilepsy in the form of anger equivalents which appeared cyclically was also observed in a ten-year-old girl. The history as given by the mother showed that she first had petit mal attacks at the age of three and these were succeeded by grand mal attacks, occurring at night, beginning at the age of four. At about the age of six the parents noticed that her temperament changed. Whereas she had previously been good-natured and mild-mannered, she now showed periods of extreme irritability and destructiveness. Curiously, the parents noticed that these excitement periods occurred about once a week. As an example, while she was at the dinner table she might suddenly accuse the mother of some slight and throw the food on the floor and proceed into a severe temper tantrum. These angers also occurred in school. On one occasion she became exceedingly aggressive against another child and tore a handful of hair from her head. On another occasion she bit a child and beat him severely before she was stopped. After her angers subsided she usually felt sorry and could not give the reason for her actions.

When these angers first appeared the mother stated that they usually occurred the day after she had had a seizure. Later they occurred without reference to the actual epileptic seizures. During these anger and destructive periods no amount of reasoning influenced her. The behavior seemed uncontrollable and compulsive.

Electroencephalographic readings immediately after these attacks showed typical epileptic tracings without hyperventilation, whereas the tracings showed typical epileptic waves only with hyperventilation when taken between attacks. On the basis of intelligence tests which had been given her over a period of five years she was less successful on succeeding examinations. Her I.Q. when she was five was 108, and when she was ten it was 79. The decrease in I.Q. was fairly regular.

In this case it may be inferred that the epileptic equivalents had an effect similar to that which grand mal attacks have, that is, an effect of reducing the level of intellectual performance.

As in the cases of deterioration due to severe and frequent grand mal, the tests showed very little scatter on any of the examinations. Her verbal ability remained fairly high, however, and this may have been the reason for a relatively high achievement in school in spite of the decreasing I.Q.

Intellectual Changes

The majority of epileptic patients who have had grand mal attacks for a long time show some degree of intellectual deterioration. Institutionalized epileptics usually are much more deteriorated than noninstitutionalized patients. They also have more severe seizures, and this may be an important reason for their institutionalization. Wilkins¹⁶ reported on a study of 254

TABLE 13
INCIDENCE OF VARIOUS TYPES OF EPILEPTIC SEIZURES
(Wilkins)

	Patients with I.Q.'s More Than 80		Patients with I.Q.'s Less Than 80		Patients with Neurological Lesions		Total
	No.	%	No.	%	No.	%	
Generalized convulsions	45	62.2	43	69.5	18	39.3	106
Generalized convulsions with minor motor or petit mal	24		14		6		44
Minor motor attacks	19	17.1	20	24.4	2	3.3	41
Localized convulsions	0	0	0	0	35	57.4	35
Petit mal with occasional convulsions	8	20.7	4	6.1	0	0	12
Petit mal only	15		1		0	0	16
Total	111	100.0	82	100.0	61	100.0	254 100.0

noninstitutionalized epileptic children. He found that approximately 44 per cent of those with an I.Q. over 80 did not have apparent neurological lesions, 32 per cent of those with I.Q.'s below 80 had no neurological lesions, and 24 per cent had definite neurological disturbances. Petit mal seizures were more common in children with normal mentality. Wilkins also found that

¹⁶ L. Wilkins, Epilepsy in childhood: I, A statistical study of clinical types, *Journal of Pediatrics*, 1937, 10, 317-328.

epilepsy is less severe in children who have normal mentality, and conversely, mental defectives are frequently associated with the more severe forms of epilepsy. Neurological disturbances are more common in epileptic children in whom the seizures begin early in life, and the frequent accompaniment of mental deficiency in those in whom epilepsy has been of long standing may well be related to the brain lesions.

TABLE 14
INTELLECTUAL RATING OF EPILEPTIC PATIENTS
(Adapted from Wilkins)

	I.Q.'s Over 80		I.Q.'s Less Than 80		All Cases
	No.	%	No.	%	
No neurological lesion....	111	57.5	82	42.5	193
Neurological lesion	22	41.5	31	58.5	53
Total	133	54.0	113	46	246

The reports that all epileptics deteriorate whether they have petit mal or grand mal have been questioned recently as a result of the careful administration of intelligence tests. Most studies have been made of institutionalized children who are frequently sent to an institution because of intellectual deterioration. In those who remain out of an institution the frequency of deterioration has been reported to be relatively small. For example, it has been shown that if the ability to continue at one's work is an index of the amount of deterioration, only 6 per cent of epileptic patients are deteriorated. The selective factor in many of the reports of intelligence tests has been pointed out by many clinicians. Dawson and Conn¹⁷ reported a series of tests of children ranging in age from four to twelve years. The mean I.Q. of the group was approximately 81, and they found that their intelligence varied from the feeble-minded level to above average. They concluded that the variability of intelligence of epileptic children was about the same as of other children. On retests, however, (only 21 children) after periods ranging from

¹⁷ S. Dawson and J. C. N. Conn, The intelligence of epileptic children, *Archives of Disease in Childhood*, 1929, 4, 142-151.

eight months to above five years the mean I.Q. was about 67. The difference was considered to be significant. They found that there was no relationship between the severity of the seizures and the mental changes. They also found no significant relationship between the degree of deterioration and the length of time the patient had had convulsions. The lack of relationship between frequency or severity of the seizures and intelligence was also reported by Patterson and Fonner.¹⁸

Most studies have shown that deterioration usually occurs after a number of years of epileptic seizures. Personality changes are usually observed more frequently than intellectual changes, although some neurologists, such as Clark,¹⁹ state that in the majority of epileptics intellectual deterioration occurs almost as soon as the seizures begin. The physical and neurological changes are not directly related to the intellectual disturbances, that is, the child who has serious neurological disturbances may not deteriorate as much as a child who shows no abnormal neurological signs. Hospitalized or institutionalized epileptic children are usually mentally deficient or at least mentally retarded. They also usually have the most severe and frequent epileptic seizures, which do not allow them to adjust either vocationally or socially. It is difficult to determine, therefore, with any degree of accuracy whether the severity and frequency of the epileptic seizures result in deterioration or whether the institutionalized epileptics represent a selective group of deteriorated individuals. Epileptics whose seizures first occur below the age of five usually deteriorate, although it is difficult to estimate the degree of deterioration because accurate yearly tests are usually not available.

Pathology

In Jacksonian epilepsy a variety of conditions have been reported both from clinical and post-mortem examinations. The histological examinations of the brains of nonorganic epileptics

¹⁸ H. A. Patterson and D. Fonner, Some observations on the intelligence quotient in epileptics, *Psychiatric Quarterly*, 1928, 2, 542-548.

¹⁹ L. P. Clark, The psychobiologic concept of essential epilepsy, *Epilepsy and the convulsive state*, 1931, Baltimore, The Williams & Wilkins Co., pp. 65-79.

have failed to show consistent neurologic changes. Many pathologists believe that the findings in the brains of epileptics are not indicative of the causative conditions. Collier,²⁰ for example, stated that epilepsy may be due to a metabolic disorder. He cited the frequency of epilepsy in early infancy when the "personal" metabolism is not as yet strongly organized. In regard to the variability of the neurological findings, he stated that there is no lesion in the brain which will definitely and certainly produce epilepsy but, on the other hand, there is hardly a lesion which cannot produce epilepsy. Disturbances of the vegetative nervous system have also been considered causative influences, although the obvious question arises whether the signs of such disturbances are merely accompaniments of the epileptic attack or whether there is a definite causal relationship. The association of function and disturbances in the vegetative nervous system with epileptic seizures was emphasized by Yakolev.²¹ He pointed to the rigidity of the pupils, the pallor of the face, followed by cyanosis, salivation, profuse sweating, post-paroxysmal fever, and the transition of the epileptic seizure into sleep as evidence of vegetative nervous system dysfunction. Thus, he assumed that the epileptic seizure develops as a "storm" in the vegetative centers.

The brains of epileptics have been found to be edematous. This has resulted in the theory that the basic pathology is an impairment of the cell surfaces with a lowering of their surface tension. Spiegel and Spiegel²² stated that the seizures are related to the transitory increase in permeability of the cell surfaces and the lowering of the threshold of the cells for metabolic or other stimuli. This mechanism supposedly explains the increase in the convulsive reactivity of the brain as the result of the edema. Many investigators have emphasized other physiological mechanisms which supposedly explain the epileptic attacks either because of their direct or indirect effects. Thus, anoxemia has

²⁰ J. Collier, Epilepsy, *Lancet*, 1928, *1*, 587-591.

²¹ P. I. Yakolev, Neurologic mechanism concerned in epileptic seizures, *Archives of Neurology and Psychiatry*, 1937, *37*, 523-554.

²² E. A. Spiegel and A. M. Spiegel, Fundamental effects of epileptogenous agents upon the central nervous system, *American Journal of Psychiatry*, 1936, *92*, 1145-1168.

been considered by some investigators to be the basis of the seizures. The anoxemia might be caused by a metabolic or vascular disturbance. For example, some neurologists believe that cerebral arteriolar spasms produce anoxemia which increases the excitability of the brain. No one has been able to explain the cause of these localized vascular spasms but it has been pointed out that localized vascular spasms in the hands and feet are not uncommon. The problem of anoxemia was investigated by Lennox and Gibbs,²³ who measured the oxygen saturation and carbon dioxide content of the arterial blood of 88 epileptic patients. In 46 per cent of the patients the initial measurement of the oxygen saturation was below the lower normal limit of 94 per cent, and in 11 per cent of the cases it was below 90 per cent. Lennox and Gibbs stated, however, that the anoxemia is insufficient in degree to be considered the cause of seizures, but it may be a contributing cause. Lennox and Behnke²⁴ also studied three patients who had many petit mal attacks. When they placed them in a compression chamber under a pressure as high as 60 pounds there was a decrease in the number of spontaneous seizures. Decreased oxygen tension tended to precipitate and increased oxygen tension tended to prevent petit mal seizures.

Post-mortem examinations have shown instances of cerebral hypoplasia and hemiatrophy. No relationship has been found, however, between the location or extent of the lesions and the severity or frequency of the attacks. Bateman²⁵ reviewed the clinical and pathologic data on a series of 178 brains of persons who had convulsions. The predominant and characteristic pathological condition was a frontal lobe agenesis. This was especially true of the brains of patients who had idiopathic epilepsy, the onset of which occurred before or during puberty. A more specific report was made by Spielmeyer,²⁶ who described

²³ W. G. Lennox and E. L. Gibbs, Oxygen saturation of the arterial blood in epilepsy, *Archives of Neurology and Psychiatry*, 1936, 35, 1198-1202.

²⁴ W. G. Lennox and A. R. Behnke, Effect of increased oxygen pressure on seizures of epilepsy, *Archives of Neurology and Psychiatry*, 1936, 35, 782-788.

²⁵ J. F. Bateman, Cerebral frontal agenesis in association with epilepsy, *Archives of Neurology and Psychiatry*, 1936, 36, 578-585.

²⁶ W. Spielmeyer, The anatomic substratum of the convulsive state, Epilepsy and the convulsive state, 1931, Baltimore, The Williams & Wilkins Co., pp. 491-501.

the histological changes of the brains of epileptics. Spielmeyer reported changes in the cerebellum and in Ammon's horn. The pathology was described as a sclerosis resembling a thick glial proliferation in circumscribed areas of Ammon's horn. Nissl stains showed a loss of ganglion cells in these parts. The changes in the cerebellum were similar to those in Ammon's horn, that is, a fibrosis replacing degenerated nerve tissue, especially Purkinje cells. Similar histological changes have been found in the brains of persons who have had convulsive attacks, irrespective of the cause of the convulsions. These changes are the same as those produced by a circulatory interference by arteriosclerosis, thrombosis, or embolism. Because there is no histological evidence of vascular stasis in the brains of epileptics, Spielmeyer supported the view that vasospasms are the important basis of the epileptic attack. Other authors have also reported that the primary cerebral lesions are vascular.

There has been some evidence that epileptic patients show general body pathology. For example, several studies have shown that epileptics have hypoglycemia which may be a factor in causing the convulsions. Some changes have also been reported in the blood pictures of epileptics. Guirdham and his associates²⁷ have reported a number of hematological changes. They found that the white cell count is variable, the greatest variability being at the time of the convulsion. There was a definite leukocytosis which was associated with the seizures, due to a relative increase in the lymphocytes. Eosinophilia rarely occurred.

The typical electroencephalographic pattern of the epileptic indicates a physiological disorder which is relatively constant. The alpha wave rhythm is often found to be especially disturbed in the frontal lobes. In general, it is believed that the synchronized mass discharge in epilepsy is in part a distortion of the mechanisms of normal brain function.²⁸ Epilepsy is probably a

²⁷ A. Guirdham, The hematology of convulsions, *Journal of Mental Science*, 1936, 82, 371-393.

²⁸ See H. H. Jasper and W. A. Hawke, Electroencephalography: IV, Localization of seizure waves in epilepsy, *Archives of Neurology and Psychiatry*, 1938, 39, 885-901; F. A. Gibbs, W. G. Lennox, and E. L. Gibbs, The electroencephalogram diagnosis in and localization of epileptic seizures, *Archives of Neurology and Psychiatry*, 1936, 36, 1225-1235.

paroxysmal cerebral dysrhythmia, a disordered functioning of the rate-regulating mechanism of the brain.

Electroencephalographic tracings of parents, siblings, and children of epileptic patients have shown definite evidence of cerebral dysrhythmia. In one study²⁹ definitely abnormal records were obtained in 60 per cent of the relatives of patients and in 10 per cent of a control group of 100 persons who had no relatives with epilepsy. The dysrhythmia occurred more often among relatives of female patients than of male patients. The investigators believed that the evidence indicated that the dysrhythmia represented a sign of a predisposition to epilepsy or some allied disorder. The evidence from this investigation showed not only a relationship between cortical activity and epilepsy but also the probability that epilepsy is inherited and that many patients have no outward signs of epilepsy that are clearly discernible but do have cerebral dysrhythmia.

²⁹ W. G. Lennox, E. L. Gibbs, and F. A. Gibbs, *Inheritance of cerebral dysrhythmia and epilepsy*, in E. A. Strecker and F. G. Ebaugh, *Practical Clinical Psychiatry*, 1940, Philadelphia, The Blakiston Co., pp. 193-195.

Chapter 10

MONGOLISM

Physical and Psychological Characteristics

Mongolism, or Mongolian idiocy, as it is popularly called, was described as a clinical entity in 1843 and has been systematically studied since 1866. Arthur Mitchell is regarded as the first investigator who described the condition in his publication in 1876.

The Mongolian idiot has a number of characteristic features. The skull is frequently small and round and the occiput is flat. The lower jaw frequently projects, and the zygomatic arches are prominent. The forehead is low and flat, although this is not a special characteristic of the Mongolian. The palpebral fissures are small, oblique and slit-like, showing some epicanthus. The fontanelles and sutures usually remain open longer than in the normal child. The skeleton is not significantly different from a normal child's, but growth in height is sometimes less rapid. The hands and fingers are frequently short and stubby, and the middle phalanges of the little fingers are shortened. The distal phalanges are curved inward and at times atrophied. The feet and toes also frequently show maldevelopment. In many cases the toes are widely separated and the joints are hyperextensal. The hair is soft and the skin smooth, moist, elastic, and redundant, appearing as if there were some underlying edema.¹

It is quite obvious that some of the peculiarities of the Mongolian are related to the unusual formation of the skull. The protruding eyes, the slanting palpebral fissures, the relatively small orbital cavity, the flat face, and the sunken nasal bones are probably the result of a structural orientation to the peculiar skull formation. Although the fontanelles do not close normally,

¹ See A. A. Werner, J. Lewald, G. A. Johns, and D. Kelling, Growth in children with Mongolism, *American Journal of Diseases of Children*, 1939, 57, 554-563.

the lack of skull growth is due to the early arrest of the development of the base of the skull. In this area there is usually early ossification and fusion of epiphyseal lines. Embryological studies have shown that the physical aberrations appear during the third or fourth fetal month. The preceding description of a Mongolian must not be interpreted as typical. These characteristics are neither invariable nor confined to that condition.

The Mongolian is only rarely an idiot psychologically. The median I.Q. of Mongolian idiots is between 40 and 50, which places the majority in the imbecile and low-grade moron classifications. On occasions a Mongolian idiot shows an I.Q. of 60 or 65, and sometimes an I.Q. below 30. The performance of Mongolian idiots on intelligence tests shows no special deviations. Mongolian idiots usually show no special defects or abilities beyond the level which they attain on a general intelligence test. Some investigators have reported that a Mongolian idiot is less likely to fluctuate in his intellectual performance than most other mental defectives. His mental gains from year to year correlate closely with his I.Q. The Mongolian's manipulative ability is even more deficient than his general intelligence. This is due to a lack of complete muscular coordination and to the frequent anatomical variations of the hands. This defective manipulative ability creates additional educational problems. Many defective children can be adjusted with some degree of adequacy in vocational activities at school. But this is not as feasible with Mongolian idiots. Their educational development is, however, helped somewhat by their personalities. The majority of Mongolian idiots are easily adjustable, are amenable to discipline and routine, and are only rarely aggressive and destructive. It is, therefore, relatively easy to work with them and to train them in routine activities.

The frequency of Mongolian idiocy has never been accurately established. In some institutions the frequency has been as high as 15 per cent of all the mental defectives, whereas in others it has been no higher than 1 per cent. In most institutions the frequency is at least 5 per cent. It has also been observed that there is an excess in boys, and in most reports this excess has been from 25 to 50 per cent.

Etiology of Mongolism

One of the current theories maintains that Mongolism is due to a germ plasm defect. This is supposedly substantiated by the fact that Mongols are usually born of women well over thirty. Also, Mongolism frequently occurs in one twin and not in the other. In cases of two ovum pregnancy Mongolism in both

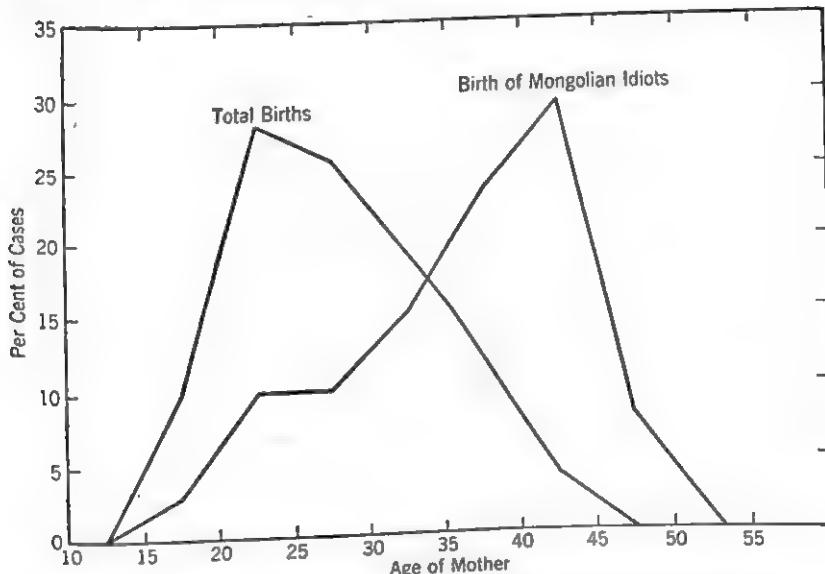


Figure 16. Distribution by Age of the Mother of Total Births and of Mongolian Idiots
(Adapted from Jenkins, p. 509)

twins of the opposite sex has not been reported, but a number of cases in like-sex twins have been reported.²

In 1934 Rosanoff and Handy³ published a summary of the cases of Mongolism in twins reported to that time. Only 64 cases of Mongolism in twins were reported in the literature. In

² R. L. Jenkins, Etiology of Mongolism, *American Journal of Diseases of Children*, 1933, 45, 506-519; T. Halbertsma, Mongolism in one of twins and the etiology of Mongolism, *American Journal of Diseases of Children*, 1923, 25, 350-353.

³ A. J. Rosanoff and L. M. Handy, Etiology of Mongolism, *American Journal of Diseases of Children*, 1934, 48, 764-779.

each of the 36 cases of dizygotic twins, only one was a Mongolian idiot. Of these, thirteen were of the same sex, six males and seven females, and twenty-three were opposite-sex twins. The evidence from these data indicates that the theory of a germ plasm defect is probably more tenable than the theory which assumes that factors occurring during pregnancy are responsible for the condition.

TABLE 15
FREQUENCY OF MONGOLISM IN TWINS
(After Rosanoff and Handy)

Type of Twin	No. of Cases	One Affected	Both Affected
Monozygotic, males	3		
Monozygotic, females	5		3
Type unascertained, males	9		5
Type unascertained, females	6	7	2
Same sex, dizygotic, males	6	4	
Same sex, dizygotic, females	7	6	
Opposite sex, dizygotic	23	7	2
Type and sex unascertained	5	23	
	64	52	12

The theory of a germ plasm pathology as a cause of Mongolism has been supported by data regarding the age of the mother. The evidence shows clearly that the age of the mother is the most constant factor associated with Mongolian idiocy. One study showed, for example, that the average age of 53 mothers at the time of the birth of a Mongol was 35.7 years. Southwick⁴ studied the records of 259 cases of Mongolism at Letchworth Village. He concluded that heredity is probably not a factor and that the occurrence of more than one case of Mongolism in a family is very infrequent. His records substantiated the belief that Mongolism occurs more frequently in children of older women and of later pregnancies. Nevertheless, numerous cases have occurred in which normal children were born after the birth of a Mongol. Thus, the age of the mother cannot be

⁴ W. E. Southwick, Time and stage in development at which factors operate to produce Mongolism, *American Journal of Diseases of Children*, 1939, 57, 68-89.

the sole responsible factor. He suggested, therefore, that Mongolism may be the result of a fertilization in which one of the gametes was in an aged condition, transitional to the nonfunctional or inactive state. The role of maternal age has also been studied by Bleyer.⁵ He concluded that the role of advanced maternal age is an important factor in the production of Mongolism. Of the many other factors which have been cited as possible causes, Bleyer concluded that the following are causative only in their relationship to advanced maternal age: immaturity of either parent, birth rank, differences between the ages of the parents, prolonged interval preceding the birth of the Mongol, low fertility, and reproductive exhaustion of either parent. Others have also pointed out that such factors as the size of the family, order of birth, and "exhaustion" play no direct etiological role but appear to be factors only because of their correlation with the age of the mother.

A number of studies have been made the results of which indicate that Mongolism may be due to a diminished viability of the ovum. Supposedly, a given mortality rate continually occurs in the ova. In that period between complete viability and failure of reproductive function the ova pass through a Mongolian-genetic stage. Some evidence for this assumption may be obtained from the fact that the birth of a Mongolian idiot is frequently preceded by a period of diminished fecundity, in spite of the fact that Mongolians are usually born toward the end of the reproductive period and especially as the last born of a long series of children. The evidence does not completely substantiate this view, however, because examination of records has shown that the Mongolian idiot is occasionally an only child. Obviously, the fact that a Mongolian is born has an important bearing upon the completion of the family. Parents who have a Mongolian rarely desire other children. Not only is there a fear of other abnormal children but the attention and effort the parents have to devote to the care of the Mongolian may also be a deterrent to further pregnancies.

⁵ A. Bleyer, The role of advancing maternal age in Mongolism: A study of 2822 cases, *Proceedings of the American Association on Mental Deficiency*, 1937, 61, 111-123.

Of the other causes which have been mentioned in the literature, syphilis has been considered important. There have been reports of twins one of whom was normal and the other who presented signs of Mongolism and congenital syphilis. The frequency of syphilis in Mongolian idiots is no greater, however, than among other mentally defective or normal children. Studies have shown that the frequency is no greater than about 2 per cent. Glandular deficiency has also been mentioned as an etiological factor. The belief that glandular deficiency plays a prominent role gains some credence from the knowledge that physiologically Mongolism may be considered to be a fetalism, that is, the Mongol is born not at physiological maturity but perhaps at the seven- or eight-month-old fetal level. It may not be improbable that the arrest in development may be due to a glandular dysfunction which is not severe enough to be detected after birth. Clark,⁶ for example, assumed that Mongolism is caused by fetal hyperthyroidism which ceases at birth. Presumably, the thyroid dysfunction may cause physical and mental defects in the same way that cretinism causes deficiencies. The extensive treatment of Mongols with various types of glandular therapy has not shown favorable results, however. It is difficult, therefore, to assume that the basis is a specific endocrine dyscrasia. Still another theory has been advanced that conditions which cause structural defects may be important factors in producing Mongolism. For example, the amniotic sac has sometimes been observed to be small, presumably due to increased pressure and excessive bending of the fetal head. Such conditions have been known to produce anencephaly and achondroplasias, depending upon the age of the embryo at the time the greatest damage was done. If the damage occurs during the sixth or seventh week of pregnancy, there is a possibility that Mongolism will result. Those who have assumed this theory have called attention to the occurrence of Mongolism and achondroplasia in twins. There is also some evidence that damage during the embryonic stage may be a factor in causing Mongolism. This is possibly substantiated by the number of structural abnormalities which are

⁶ R. M. Clark, The Mongol: A new explanation, *Journal of Mental Science*, 1929, 75, 261-262.

found in Mongols, such as cleft palate, hare lip, and abnormalities of the extremities.

As mentioned previously, the term Mongolism is often misleading because it implies facial characteristics and perhaps also bodily development related to Mongoloid characteristics. There



Figure 17. Mongolian, One Year Old
(Courtesy of Dr. I. P. Bronstein)

have been many statements in the literature regarding the absence of Mongolian idiocy among given races, especially the Orientals and the Negroes. If Mongolism is to be regarded as a type of fetalism, there is no reason to assume that it cannot occur in any racial group. Investigators have studied this problem recently and have given ample evidence of the existence of

Mongolism among all races. Scott,⁷ for example, in a publication in 1939 cited references and presented case material refuting the previous reports that Mongolism does not occur in Negroes. He presented six case histories of Mongolian idiocy in Negroes and stated that the total number of Negro cases officially recorded at the time was 44. This does not mean that many other cases do not exist. They are probably either overlooked or, because of the general notion that Mongolism does not occur in given races, a different diagnosis is made.

Brain Pathology

Some histological studies have given evidence of brain pathology, whereas others have shown no definitive pathology. Meyer, Bonn, and Jones⁸ reported on a histological study of fifteen cases of Mongolism. In five cases they found no significant changes and an apparently normal amount of glia in the subependymal regions, olfactory body, dentate nucleus, and cerebellar white matter. In the remaining cases the changes were subependymal. There was widespread proliferation of the glia which usually did not correspond to any serious breakdown of the parenchyma. The overgrowth was observed especially in the cerebral and cerebellar white matter and in the pons and medulla. There was no evidence to substantiate the assumption that the glial changes were signs of maldevelopment, nor was there any evidence of a glastomatous glial overgrowth as in tuberous sclerosis. Gliosis with little or no demyelination is usually considered a special type of lesion. A number of pathologists reported that this frequently occurs in low-grade defects to Meyer these changes are probably incidental to the etiological pathology of Mongolism. They also concluded that because uniform changes were not found in all the cases they studied, the pathological changes which they observed could not be the basis of the mental defect in Mongolism.

⁷ R. B. Scott, Clinical Mongolism in the Negro, *Archives of Pediatrics*, 1939, 56, 4-18.

⁸ A. Meyer, M. D. Bonn, and T. B. Jones, Histological changes in the brain in Mongolism, *Journal of Mental Science*, 1939, 85, 206-221.

The brain of the Mongolian is usually slightly smaller than the brain of the normal child. The deficiency frequently occurs in the pons, medulla, and cerebellum. The diminution in the size of the pons and medulla can probably be explained on the basis of the imperfect development of the base of the skull which results in the imperfect development of the basal parts of the encephalon.

The suggestion by some investigators that Mongolism may result from lack of proper fetal growth due to endocrine dyscrasia has led investigators to make pathological studies of the endocrine system. Studies of the thyroid,⁹ for example, have shown no specific histological signs of hyperactivity or involutional changes. In a number of cases the thyroids have been found to be in a stage of development that did not correspond with the chronological age. Both colloid and parenchymatous types of goiter have also been observed. The histological picture of the thyroid in Mongolism frequently indicates a condition similar to goiter but not enlarged. Studies of other endocrine glands have failed to show significant differences between Mongolian and normal individuals.

Studies have been made on the cholesterol content of the blood and the blood sugar of Mongolian idiots. There have been no consistent findings, however, to indicate differences between the biochemical functions in Mongols and in normal children. A number of electroencephalographic studies have also been made of Mongolian idiots. Except for some indication that the alpha wave frequency and amplitude showed some relationship to mental age, no significant findings have been reported, although many claims have been made.¹⁰

⁹ See C. E. Benda, Studies in Mongolism: II, The thyroid gland, *Archives of Neurology and Psychiatry*, 1939, 41, 243-259.

¹⁰ See G. Kreezer, Intelligence level and occipital alpha rhythm in the Mongolian type of mental deficiency, *American Journal of Psychology*, 1939, 52, 503-532.

Chapter 11

CRETINISM

The frequency of cretinism has not been accurately established. This is due in part to the lack of statistical data regarding the frequency of endocrine dysfunctions in the general population, and in part because the degree of hypothyroidism which defines a cretin has not been specifically established. In a study of 3,548 children in subnormal classes, Kimball and Marinus¹ discovered that 17 per cent had some endocrine dysfunction. Of those who were diagnosed as congenitally hypothyroid, approximately 44 per cent showed an almost normal rate of growth with an I.Q. below normal which remained constant. One hundred and seventeen children showed a consistent decrease in I.Q. The authors stated that ifcretins are untreated their mental age seldom rises above the six-year level.

In most cases of sporadic spontaneous cretinism the thyroid tissue is entirely absent² or aplastic. In the infantile myxedemas the deficiency of the thyroid occurs during extrauterine life. The symptoms appear later and differ in degree from the spontaneous cretinisms.

Symptoms of Cretinism

The symptoms of cretinism usually appear after the first six months of life and often remain unnoticed until two or three years of age. Only rarely is it possible to make an accurate diagnosis in infants under six months of age. The characteristic of cretinism is the failure to develop physically in a normal way because of the low metabolic activity. The child has a somewhat

¹ O. P. Kimball and J. C. Marinus, The relation of endemic goiter to mental deficiency, *Annals of Internal Medicine*, 1930, 4, 569-577.

² See L. E. Holt and J. Howland, Diseases of infancy and childhood (Eleventh ed., revised by L. E. Holt and R. McIntosh), 1940, New York, D. Appleton-Century Co., Inc., pp. 687-698.

puffed appearance of the face, the forehead is relatively low, and the eyes appear widely separated. The hair is typically coarse, dry, and sparse. Important skeletal changes also occur.



Figure 18. Cretin, Age Twenty-Three
This patient has been treated for the past six months.

The body is dwarfed and frequently retains the proportions of early infancy. For example, even at the ages of eight or ten the measurement from the navel to the sole is often less than from

the navel to the crown. There is incomplete growth at the epiphyseal junctions. The centers of ossification appear relatively late. The fontanelles frequently remain open until the ages of eight or ten, and the cranial bones are thickened. The teeth appear late and frequently show early decay. Many of the cretins do not walk until five or six years of age, and their movements are slow. The basal metabolic rate varies, but it has been reported to be generally from -40 to -50 per cent.

Post-mortem examinations of cretins have verified the clinical findings of the absence of the thyroid gland. Bronstein and Milles³ reported on the post-mortem examination of two cretins. They believed that the atrophy of the thyroid gland may occur spontaneously shortly before or after birth or following childhood infectious or toxic diseases. They reported that in their post-mortem examinations they found no pathology of the brain.

The intellectual deficiency of cretins varies greatly. Some psychologists have reported that children with all the physical signs of cretinism may be of the higher type of mental deficiency, with I.Q.'s between 50 and 60. A majority of reports show, however, that cretins are usually low-grade mental defectives and generally classified in the imbecile group. Except in cases of relatively early treatment, the I.Q. does not change and remains relatively constant irrespective of the environmental or educational therapy. In cases of cretinism due to disease processes arising early in childhood, the I.Q. may be variable and show a constant decrease. The reports of some investigators, such as that of Kimball and Marinus, previously cited, I.Q., have not been verified. In those cases with a decrease in I.Q., the basic condition is frequently not that of true cretinism but it is some degree of hypothyroidism. The intellectual deterioration is the result of an increasing hypothyroidism.

³ I. P. Bronstein and G. Milles, Hypothyroidism and cretinism in childhood: IV, Post-mortem reports on two cretins, *American Journal of Diseases of Children*, 1935, 49, 1564-1569.



Figure 19. Cretin, Age Thirteen (brother of the 23-year-old)—untreated

Psychiatric Aspects

Myxedema patients often show psycho-motor retardation with depression, irritability, and apathy.⁴ The patients show a tendency to perseveration of ideas and acts and obsessive-compulsive behavior. Orientation for time and place is not impaired, but there is a deterioration of memory. The patients are unable to work at tasks requiring sustained mental effort. Psychoses have been reported to occur in about 15 per cent of cases of myxedema. The most frequent type of disturbance is a delirious hallucinosis, with clouding of consciousness and disorientation. Ruhberg⁵ reported that irritability, depression, clouding of consciousness, and delirium may occur in myxedema. These symptoms depend upon the degree and duration of the thyroid insufficiency. In cases of uncomplicated myxedema the mental picture is that of psycho-motor retardation, slow, placid reactions, loss of initiative, difficulty of concentration, progressive loss of memory, and somnolence.

Pathology

As mentioned previously, many neurologists have reported no specific changes in the brains of cretin patients. Some investigators believe, however, that changes are inevitable if the cretinism has existed for a long time. Eaves and Croll⁶ claimed that definite changes usually occur. In a report of a histological examination of the brain of a girl who died at fifteen, they stated that it was normal in size for a girl of seven of the same weight. Histologically, there was chromatolysis of the nerve cells and an accumulation of fatty granules. This change was marked in the sympathetic ganglia and to a slight extent in the cerebellum as well as the cerebral cortex. In the cerebral cortex the nerve cells were sparse and atypically arranged. No typically

⁴ See A. J. E. Akelaitis, *Psychiatric aspects of myxedema*, *Journal of Nervous and Mental Disease*, 1936, 83, 22-36.

⁵ G. N. Ruhberg, *Myxedema: Its nervous and mental manifestations*, *Minnesota Medicine*, 1936, 19, 637-641.

⁶ E. C. Eaves and M. M. Croll, *A case of nervous cretinism with histological examination of the organs*, *Journal of Pathology and Bacteriology*, 1928, 31, 163-172.

large Betz cells were observed in the Rolandic area. They found that the afferent tracts were well myelinated, whereas the efferent tracts were poorly myelinated. Some corroborative evidence of the findings of Eaves and Croll has been produced by investigators who have studied animal pathology. Dye⁷ examined sections from the motor cortex, the thalamus, the mid-brain, the cerebellum, the medulla, and cervical cord from each of five cretin lambs and two cretin goats. Dye examined the sections microscopically by a modified Nissl technique. Normal twin animals were used as controls. For comparison sections were made from the brains and the spinal cords of thirteen dogs in which tetany was experimentally induced. In each group there was a definite chromatolysis which was not distinguishable in the three conditions. Chromatolysis, however, may be regarded as a general reaction of nerve cells and if carried beyond given physiological limits it may be considered pathological. In a later publication Dye⁸ further reported on changes in cretinism. This was a report of a study of ten cretin (thyroidectomized) and four normal sheep and goats. For fixation of the brain representative sections were taken from the cervical cord, medulla, midbrain, cerebellum, and the superior frontal convolution of the cerebral cortex. The microscopic examination of preparations from three thyroidectomized lambs showed cell alterations of a chromatolytic nature. Not all cells were equally affected, however. In some cells the extranuclear chromatin was increased. The Nissl bodies were swollen and rounded. The changes in the medulla were less pronounced. Dye again pointed out that chromatolysis is a reaction of the chromatin apparatus which may lead to complete degeneration of the cell. There is at first an increase in the amount of iron-reacting materials in the nucleus, followed by a diminution to below normal. There is an unusual decrease in the size of the cells followed by gradual swelling. Vacuolization of the cytoplasm occurs. These

⁷ J. A. Dye, Comparable cell changes in the central nervous system in cretinism, parathyroid tetany, and fatigue, *Proceedings of the Society for Experimental Biology and Medicine*, 1925, 23, 119-121.

⁸ J. A. Dye, Cell changes in the central nervous system under various natural and experimental conditions: II, Cretinism in sheep and goats, *Quarterly Journal of Experimental Physiology*, 1927, 17, 91-105.

alterations are, however, not specific and are believed to be due to a state of depressed metabolism resulting from a loss of the thyroid hormone.

From the histological examinations of the brains of cretin patients and from the investigations of experimentally induced cretinism in animals, it may be seen that the central nervous system pathology is not specific for cretinism but occurs as the result of a metabolic disturbance. Thus, the intellectual retardation and the psychiatric symptoms of the cretin patient cannot be ascribed to specific pathology. There is some probability, as some investigators believe, that after a long period of cretinism the intellectual and mental symptoms may become more severe because of the coincidental destruction by chromatolysis of the nerve cells of the cerebral cortex.

Effect of Treatment

There has been a great deal of controversy regarding the results of the treatment ofcretins with thyroid substance. It is generally known that the earlier the treatment is instituted the more favorable is the prognosis. Practically, a difficulty arises in the efficacious treatment ofcretins because a diagnosis is frequently made not earlier than the second or third year, in part because the symptoms often do not manifest themselves significantly earlier in infancy and in part because parents usually do not take a child for examination until the symptoms are well developed. It is relatively easier to improve the physical condition of the cretin than his mental condition. Improvement of the mental condition is either impossible or is slight if a cretinous child has had no treatment until the age of six or seven. In spite of the general knowledge that improvement is extremely slow when it occurs, or does not occur at all in many instances, some investigators have reported marked improvement as the result of treatment. For example, Lewis and his co-workers⁹ stated that it is possible forcretins to become mentally normal. They believed that promptness and continuity of thyroid ad-

⁹ A. Lewis, N. Samuel, and J. Galloway, A study of cretinism in London with especial reference to mental development and problems of growth, *Lancet*, 1937, 2, 5-9.

ministration are important. They also believed that the degree of nonthyroid cerebral damage as well as environmental and hereditary factors are important influences in the effect of treatment upon the improvement of the mental level. Gesell and his co-workers¹⁰ have recently reported on the treatment of six

TABLE 16

CHANGE IN THE DEVELOPMENTAL QUOTIENT UNDER TREATMENT
(Gesell *et al.*)

	Patients						
	D	D	N	N	N	N	weeks
Mental status attained	D	D	N	N	N	N	
Age at which thyroid began.....	105	36	80	21	46	27	
Original developmental quotient....	25	40	50	45	50	15	
Gain in developmental quotient.....	15	20	25	30	40	65	

D, defective; N, normal.

cretinous infants. They reported that thyroid substance had an immediate effect upon metabolism and the vegetative system. The mental status varied from persistent mental deficiency to normal intelligence. Some reports have appeared in the literature regarding improvement at other age levels. Brown and his collaborators¹¹ reported that a slight increase in I.Q. was observed during the period of treatment, but they pointed out that the increase was greatest for those who began treatment early. They stated, however, that even with treatment most children remained severely retarded, with I.Q.'s below 70.

Whatever the effect of thyroid medication may be on the intellectual growth, treatment usually benefits a child in other ways. The increased reactivity and alertness may allow a child to adjust himself more adequately, even if his intelligence level is not raised. His improved physical appearance may make him more acceptable to others and thus benefit him by improving his social adjustment.

¹⁰ A. Gesell, C. S. Amatruda, and C. S. Culotta, Effect of thyroid therapy on the mental and physical growth of cretinous infants, *American Journal of Diseases of Children*, 1936, 52, 1117-1138.

¹¹ A. W. Brown, I. P. Bronstein, and R. Kraines, Hypothyroidism and cretinism in childhood: VI, Influence of thyroid therapy on mental growth, *American Journal of Diseases of Children*, 1939, 57, 517-523.

Chapter 12

MENTAL TESTING

The Development of Intelligence Tests

The use of specific mental tests for diagnostic purposes developed rapidly after the publication of the experimental work by Binet in France. Previously, investigations of intelligence were confined mostly to the diagnosis of mental defectives and occasionally to delinquents. As early as 1820 there was an interest in a precise intellectual differentiation of people, but little was done until Wundt developed his psychological laboratory in Germany. The first specific test of intelligence did not develop, however, until 1885 when Ebbinghaus reported a series of experiments on the testing of memory. In 1897 he developed a series of tests at the request of school authorities in which he attempted to measure those intellectual activities which were significant for school achievement. The tests included problems in memory, computation, and a form of completion test which later began to be used in many intelligence scales. At about the same time Kraepelin began a series of studies on the intelligence of the insane. These studies were part of his larger series of studies on the classification of insanity, a classification which is still used widely by psychiatrists. A number of his pupils later further developed the Kraepelin tests, especially in their work on psychotic patients. The cancellation test which Kraepelin developed was used for a long time and is even now employed, but not as a test of general intelligence. Many other German psychologists continued this work.

Individual differences began to be emphasized by psychologists in England at the close of the nineteenth century. Francis Galton was one of the leaders in psychology at that time, and he developed mental tests which involved methods of examina-

tion quite different from the psychophysical methods which were used in Germany. In Germany, Fechner conducted experiments involving psychophysical measurements by which individuals were differentiated. Galton, in England, introduced definite statistical methods by which the data were evaluated. By the use of averages and dispersions and correlation techniques, he was able to utilize the tests much more effectively than those who preceded him. Karl Pearson elaborated the statistical techniques. In 1904 Spearman¹ reported his theories of the nature of intelligence, and he has continued to work in this field. The statistical methods which Pearson and Spearman introduced made possible the experimental evaluation of mental tests and stimulated further investigations. Previously only indirect attempts were made to standardize tests or to discover the ways in which individuals are distributed on a scale. For example, although Münsterberg did a great deal of work during the last decade of the nineteenth century in perfecting tests for school children, he did very little to standardize them. His tests involved the measurement of perception, judgments of weight and distance, and coordination. He was the first psychologist to consider the factor of speed a criterion of ability.

In France the most important work on intelligence testing was done by Binet. A definite indication of his interest in the measurement of comparative abilities can be found in his publications in 1895. In 1904 he was appointed on a committee which was requested to formulate recommendations for the conduct of special classes in public schools. In 1905 he reported a new method for the diagnosis of the intellectual level of abnormal children. At that time he formulated the concept that an intelligence test must be simple, must not take a long time to administer, and must be relatively unrelated to the academic work. He attempted to standardize his tests into an age scale by which a rank order distribution could be made of any number of school children. His first scale was revised by him in 1908. There were improvements in the method of giving some of the tests which were arranged in definite age group sequences.

¹ C. Spearman, General intelligence objectively determined and measured, *American Journal of Psychology*, 1904, 15, 201-293.

He thus was able to obtain a mental age of each child. In 1911 the second revision appeared. In this revision some of the tests which depended upon scholastic ability were omitted, and the number of tests in each age group was made uniform. Binet recognized many of the difficulties in making an accurate diagnosis of intelligence. For example, he recognized that the tests depended too greatly upon the environment of the child and upon his formal education. No other work in the field of testing aroused so much interest as Binet's, not only in France but also in many other countries.

In this country the work of Cattell first called attention to the problem of intelligence testing. Cattell returned to this country after studying with Wundt and Francis Galton, and proposed a program of intelligence tests. He wanted to study the constancy of mental processes and the degree to which they varied from time to time and under different circumstances. Cattell was influenced by the work of Fechner, Wundt, and Ebbinghaus, and his tests consisted essentially of the measurement of sensory processes, speed of movement, memory, and judgment. He emphasized the factor of individual variation and conducted a number of experiments on college students. In 1901 Wissler² published the results of these tests and for the first time in this country used the correlation technique. He reported, for example, that there was only a slight relationship between motor and sensory abilities and academic ability. This finding stimulated research on the measurement of intellectual processes in ways other than by the measurement of psycho-physical processes. Tests of motor coordination, of learning, and of association were developed by psychologists at this time.

The scale developed by Binet was quickly introduced into this country. Goddard, working at the Vineland Training School, first began to use the Binet scale in 1908, and in 1910 published his standardization on the basis of the examination of 2,000 children.³ Goddard used his scale to test feeble-minded children. At this time the professional psychologist still maintained the

² C. Wissler, The correlation of mental and physical tests, *Psychological Monographs*, 1901, 3, No. 6.

³ H. H. Goddard, A measuring scale for intelligence, *The Training School*, 1910, 6, 146-155.

attitude that intelligence tests were for the purpose of diagnosing feeble-mindedness, and there was a good deal of hesitancy to adopt this technique for the diagnosis of the intellectual capacities of normal children. In 1910, however, Huey began to test normal children with the Binet scale, and in a very short time further revisions were made of the Binet tests. The routine testing of children developed rapidly after 1916 when Terman of Stanford University published his first revision of the Binet scale. For the first time in this country schools began to test the intelligence of normal children, although it was not until many years later that the testing of all children was considered a routine school function.

At this time many other psychologists began work on the construction of other types of intelligence tests. A number of group tests were developed. Schools could not afford to give individual tests because of time and expense, and when the first group tests were published they were rapidly accepted. The impetus to group testing increased during 1917 and 1918 when Otis, Yerkes, and Yoakum developed group tests for adults. The testing program during the World War obviously could not be conducted by giving each soldier an individual test. The Army mental tests solved the problem because they could be administered to as large a number as could be accommodated in an appropriate testing situation. At this time many performance tests were also developed. Psychologists became aware of the effect of language handicaps and sensory defects upon the results of the Binet type of mental tests. Performance tests at least partially solved these problems.

The latest of the revisions by Terman and Merrill was made in 1937. The 1937 tests include important improvements upon the previous revision of the Binet scale. The tests were extended in both age directions, and better norms were obtained. Kuhlmann also revised the Binet, first in 1912, then in 1922, and finally in 1939. Many changes took place in these revisions, and the 1939 tests contain relatively few of the original items used by Binet. The standardization by Kuhlmann was a great improvement on the original standardization by Binet or the earlier revisers. Kuhlmann, for example, standardized the

tests by careful selection of children on the basis of birth registration. The items that were used were more independent of the effects of training, and the scoring methods were more objective. Both speed and accuracy were stressed, and a greater emphasis was placed upon speed.

Most of the tests for children have been mental age scales, that is, the score that a child made is represented by the mental age which he attained. The mental age scale has the advantage of immediately giving the examiner the results of the test in terms of a rank order for a comparison with other children. In 1915 Yerkes and his co-workers⁴ published a revision of the Binet, in which a point scale rather than an age scale was employed. In such a scale the child is given a number of points for each test he passes, and the mental age is then calculated by the number of points which he has amassed. The point scale is somewhat more flexible and at times more accurate in determining the exact mental age.

Testing Performance

Performance tests were developed in order to meet the criticism that tests like the Binet place an undue emphasis upon verbal ability. In a performance test a child is called upon to solve concrete problems which do not require verbal responses. The factor of speed can be more accurately controlled in performance tests than in individual verbal tests. The same tasks can be given to persons of different ages by merely increasing or decreasing the number of items or allowing more or less time for the completion of the tasks. The fact that performance tests do not require either written or oral language responses allows them to be used in a much wider range than the other tests. Persons with speech defects, hearing deficiencies, and those whose environmental backgrounds have handicapped their verbal ability can be tested fairly adequately and uniformly. The first of these performance tests were form boards such as the Seguin Form Board. In these form boards the child was re-

⁴ R. M. Yerkes, J. Bridges, and R. Hardwick, A point scale for measuring mental ability, 1915, Baltimore, Warwick & York, Inc.

quired to place blocks of various shapes into recesses of corresponding forms. Thus, the child could be tested for recognition, discrimination, memory, and coordination. Some psychologists believe that the introduction of form boards and other performance tests enabled clinicians to observe qualitative aspects of intellectual behavior different from those which could be recognized with the ordinary verbal tests.

The factor of speed in a performance test should not be confused with mere motor speed because the performance on such a test involves accurate perception and understanding of relationships. The motor activity is merely the end result of many correlative aspects of intelligence. In addition to the simple form boards, other performance tests were rapidly developed, such as those involving picture completion, maze performance, construction of designs, and solving of puzzles. The Goodenough Draw-a-Man test is an excellent illustration of a performance test which can be accurately scored and which shows a high correlation with general intelligence tests. The standardization of the Goodenough test was made on the basis of 4,000 drawings by children of the kindergarten and first four grades.

One of the greatest difficulties with performance tests is that they usually have little value in the upper ranges of intelligence or for older children and adults. Newer tests are being developed, however, which enable the psychologist to differentiate individuals over a wide age range. For example, the Kohs block design test is one of the more recent performance tests in which a wide age range can be included. Psychologists recognized some time ago that a single performance test does not allow for a precise differentiation between one child and another. Chance successes or errors as well as other factors frequently interfere with an accurate diagnosis. In consequence, performance scales were developed which were composed of a number of performance tests. One of the earliest of these scales was developed by Pintner and Paterson and is known as the Pintner-Paterson scale of performance tests. It is composed of fifteen tests and allows for several methods of computing mental age. For example, a year scale, a median mental age, and a percentile rating

can be obtained. Most of the tests in this scale as well as in other scales involve form board performance and picture or puzzle completion. Another well-known scale is the Grace Arthur performance scale. This scale covers an age range from five to fifteen with extrapolated extension to twenty-one years. A given number of points are allowed for given levels of performance on the tests. There are two forms, the first of which includes nine separate tests, and the second, eight. In 1934 Cornell and Coxe developed a performance scale. They believed that a performance scale was in many ways better than verbal tests because it allowed for the testing of individuals in many varied situations. It allowed also for conclusions to be drawn from a wide range of performances. In addition to these values, the Cornell and Coxe scale allowed the psychologist to make conclusions regarding specific abilities such as mechanical ability and motor dexterity and control. This scale has an age range of six to fifteen and one-half and is composed of seven tests. In addition to the individual performance tests, group tests have also been developed. The best known of these group tests is the Army performance scale (Army Beta) which was developed shortly after the Army mental tests were first used.

Intelligence tests for preschool children were introduced only relatively recently. In 1922 the Merrill-Palmer scale for the measurement of the intelligence of preschool children was developed. These tests measured a wide range of activities, including physical and manipulative acts, and simple language responses. Arnold Gesell, of Yale, has done the most extensive work on the development of tests of infants and preschool children. He believes that intelligence develops in an orderly, sequential manner and that a measure of an infant's ability at any period should give a prediction of the subsequent intellectual growth. The measurements which Gesell stressed in his scales were those involving motor reactions, such as coordination, language responses including vocalization and speech, auditory comprehension, personal social reactions, and adaptive behavior. Gesell considers these tests measures of development. He believes that the normal child, that is, the child without physical handicaps

and in a normal environment, matures intellectually in an orderly and regular fashion. Recent experimentation, as has already been mentioned, has shown, however, that the correlations between the scores on infant scales and scores obtained later on general intelligence tests are not very high. One of the reasons may be that different intellectual functions are measured at different ages and, although intelligence may develop in an orderly fashion, the tests may not be adequate to measure it at different periods.

Group tests for adolescents and adults are valuable because a large number of individuals may be examined at one time. As mentioned previously, it is the general opinion of psychologists that the scores obtained on group tests are not as accurate measures of intelligence as those obtained on individual tests. A group test is affected by such variables as willingness to work in a group, cooperation, fatigue, distractability, and interest. The majority of group tests involve written responses. They include such material as analogies, the rearrangement of disarranged sentences, true-false questions, word completion, arithmetical calculation, sentence completion, information, and in some cases, vocabulary. In some scales nonverbal material is also included, such as code tests, picture completion which requires the individual to add some omitted part, and the identification of objects and their relationships. One of the most important tests was developed by Thorndike and is known as the CAVD (completion, arithmetic, vocabulary, and directions) test. This test is thus essentially a power test and is in that sense comparable to the Binet intelligence test. Terman also developed a group test known as the Group Test of Mental Ability. There are now many other types of group tests which can be easily administered and scored.

When intelligence tests came into common usage in clinics and schools, psychologists turned their attention to tests involving special abilities. Tests of mechanical ability, special skills, and talent were developed in rapid succession. Examples of the most commonly used tests are the Seashore test of musical ability and the Stenquist test of mechanical ability. Tests of

achievement were also developed. These came into use principally because it was recognized that a child's school placement could not be made on the basis of his intelligence test score. Children of high mental ability frequently cannot do the work in the school grade in which children of lesser ability may adjust adequately. Achievement tests solved this problem partially because the psychologist was able to evaluate the actual level of performance irrespective of the basic ability. The use of these achievement tests will be discussed later.

Types of Intelligence Tests

An adequate evaluation of an intelligence test score requires a careful appraisal of the type of responses and the scatter of successes and failures. As an example, it is extremely difficult to differentiate between an individual who is deteriorated and one who is congenitally defective on the basis of a test score. It is necessary to compare the items on which the individual succeeded and those on which he failed. It is also necessary to compare the basal age, that is, the lowest age level at which all the tests are passed, with the upper limit and with the mental-age score. As an example, a scatter of eight years or more on the Stanford-Binet test indicates either a lack of attention because of an emotional disturbance or a mental dissociation due to a psychotic or organic disturbance. Juvenile schizophrenics, for example, show a wide scatter but show no actual deterioration for many years after the onset of the psychosis. The scatter may involve different items at different times, but the intelligence test scores remain relatively stable.

In order to select a suitable intelligence test, a variety of factors must be taken into account. The age of the individual determines the type of test that can be used successfully. The environmental background, the adequacy of the patient's use of language, his previous training, and the presence of motor or sensory defects must also be considered in determining the use of one or another test. Tests have been classified according to their use with different age groups. Thus there are preschool tests, school-age tests, and adult tests.

Preschool Tests

Preschool tests have been used extensively in recent years partly in order to predict the mental development of a child. As we have seen previously in the discussion of mental growth, studies have shown that there is a relatively low correlation between the results on preschool tests and the results on ordinary intelligence tests at a later age. This is due not to a different rate of growth at any one period but rather to the different types of tests. The preschool tests, especially those designed for children below two years of age, must necessarily measure mainly sensori-motor adequacy. Although it is well known that the rapidity with which adequate sensori-motor activity develops determines the intellectual development level later on, it is also known that the method of measurement is distinctly different when using sensori-motor tests and when using tests involving verbal and abstract performance.

To a great extent the tests of infants can be classified as laboratory or "experimental." The infant's performance must be stimulated on each item and is thus unlike the performance of, say, a ten-year-old who is given a general statement, following which he proceeds to solve a series of problems in an orderly fashion. It is difficult to interpret the results of infant tests because of the rapid mental growth. Within a period of a week or two given responses are perfected, and the rudiments of new ones appear. Thus, small age differences must be evaluated, and the possibilities of error are consequently great. Most of the infant tests must necessarily be divided into monthly periods, whereas the tests for older children are often graded on the basis of year differences.

Of the many infant scales in current use that of Gesell⁵ has attracted wide attention. His scale consists of a series of behavior items standardized on the basis of monthly increments of response adequacy. The tests involve motor language, adaptive, and personal-social responses. The motor items predominate, however, during the first twelve months.

⁵ A. Gesell, *Infancy and human growth*, 1938, New York, The Macmillan Co., pp. 128-135; A. Gesell and C. S. Amatruda, *Developmental diagnosis*, 1941, New York, Paul B. Hoeber, Inc.

The following are examples of the test items in Gesell's developmental scale. In regard to the motor development, at the one-month level the infant is supposed to be able to lift his head from time to time, to make crawling movements, and to turn his head laterally when in a prone position. From the standpoint of language, he is supposed to give definite heed to sound and also to have differential cries for discomfort, pain, and hunger. From the standpoint of adaptive behavior, the examiner observes whether he stares at objects, gives his attention to moving objects, and retains hold of an object when placed in his hand. From the standpoint of personal-social behavior, the examiner observes whether he makes perceptual postural adjustments when taken up and whether he shows selective regard for faces.

The same categories of behavior are employed for the increasing levels up to and including thirty months of age. For example, at the six-month level the infant is expected to sit momentarily without support, to grasp with simultaneous flexion of fingers, and to retain for some time objects placed in both hands. At the six-month level he is also expected to vocalize several syllables, express recognition, reach for and pick up objects, play with objects, and to discriminate between persons.

At the twelve-month level Gesell's schedule measures the ability of the child to walk with some help, to lower himself from standing to sitting positions, to say at least two words, to adjust to simple verbal commands, to imitate movements, to hold the cup from which he drinks, and to repeat simple performances. At the eighteen-month level more complex motor development is measured, such as the ability to climb stairs or a chair, to use his hands in adaptive motor skills, to say at least five words, to attempt conversation, to construct from small objects, to eat with utensils, and to observe pictures attentively. At the twenty-four-month level the motor development is expected to be quite skillful. The child is supposed to run and walk with good coordination, build some blocks, to name objects definitely, to use words in combination, to play with mimicry, and to tell and explain experiences. At the thirty-month level similar behavior to that of the twenty-four-month level is measured except that it is expected to be more organized, more

motivated, and the child is expected to have specific goals and be able to persevere in his behavior.

The Gesell schedule has been criticized because of the vagueness of many of the items and the difficulty of quantifying the responses. For example, in the one-month level, the examiner is supposed to decide whether the infant makes differential cries for discomfort, pain, and hunger. Some experimental evidence has shown, however, that it is extremely difficult, if not impossible, to differentiate the nature of young infants' cries. One of the many other examples of the difficulty of objective scoring of the Gesell schedule is in the twelve-month level when the infant is supposed to adjust to simple verbal commands. The term adjustment is obviously vague, for it may mean any sort of response. Thus, subjective interpretations may determine whether given responses are considered successes or failures.

Most preschool scales measure a child's intelligence by means of a combination of verbal and performance tests. Some of the preschool scales are predominantly verbal and attempt to measure abilities similar to those which are measured by the items in a general intelligence test designed for older children. Other preschool scales are predominantly performance tests. The Minnesota Preschool Scale, which was developed by Goode-nough, Foster, and Van Wagenen,⁶ has been used widely since it was first published. The scale was developed by obtaining norms which were based upon the results of the testing of 100 children at each of nine half-year age levels. Test items which were of greatest interest to children were then selected and standardized. There are two alternate forms, A and B, which differ in the individual items. Many of the items are similar to those used in the Stanford-Binet scale⁷ and in the Kuhlmann-Anderson test.⁸ For example, the child is required to point out parts of the body on a doll, to recognize objects, pictures, to copy drawings, and to name colors. Other items which are similar to those in the Stanford-Binet and Kuhlmann-Anderson are the imita-

⁶ F. L. Goodenough, J. C. Foster, and N. J. Van Wagenen, Minnesota preschool scale, manual form A, 1932, Minneapolis, Educational Test Bureau.

⁷ L. M. Terman and others, The Stanford revision and extension of the Binet-Simon scale for measuring intelligence, 1917, Baltimore, Warwick & York, Inc.

⁸ F. Kuhlmann and R. G. Anderson, Kuhlmann-Anderson intelligence test, 1933, Minneapolis, Educational Test Bureau.

tion of drawings, response to commands, recognition of forms, the completion of pictures, and the memory of digits. This test has an advantage over other tests because of the care the authors used in standardizing it and because the combination of verbal and nonverbal items compensates for language difficulties. The use of a number of common objects such as dolls, cups, cubes, and tennis balls allows for common responses and the scoring is therefore relatively simple. The authors emphasize that the tests may furnish a great many data in addition to the actual score. The individual test record contains space for the gathering of data on the habits, social and emotional characteristics, and interests of the child, the family history, and the methods of management.

The Merrill-Palmer Preschool Scale⁹ was developed by Rachel Stutsman of the Merrill-Palmer School. It measures the intelligence of children from eighteen months to seventy months of age. It is mostly a performance test although there are a number of language items and a number of form boards such as the Seguin, manikin, and mare and foal. Correlation with other scales has been reported to be extremely high, and it is considered a better test for preschool children who have not had formal schooling than the scales which depend upon verbal directions and language responses.

Many other tests have been in common use. The Linfert-Hierholzer¹⁰ scale was published in 1928 and was designed to measure the intelligence of infants below one year of age. The California First-Year Mental Scale,¹¹ developed by Bayley, has been accepted as a well-standardized and validated scale.

School-Age Tests

Most of the tests used for measuring the intelligence of children of school age are known as "general" intelligence tests. Many types of items are included in these tests, but their aim

⁹ R. Stutsman, *The mental measurement of preschool children, with a guide for the administration of the Merrill-Palmer scale of mental tests*, 1931, Yonkers-on-Hudson, World Book Co.

¹⁰ H. Linfert and H. N. Hierholzer, *A scale for measuring the mental development of infants during the first year*, 1928, Baltimore, Warwick & York, Inc.

¹¹ N. Bayley, *The California first-year mental scale*, 1933, Berkeley, University of California Press.

is mainly to measure a child's ability to form concepts. One of the most serious criticisms of general intelligence tests is that they measure, to a great extent, verbal ability and verbal symbolism. It is quite evident, however, that, whatever the definition of intelligence, its manifestation is by symbolic behavior in which verbalization, vocal, motor, or gestural, is the most important factor. In general, the higher the level of performance the more symbolism and verbal ability are involved. The clearest example of the importance of symbolism in the tests is in the differences between the items on the two- or three-year-old levels and those on the ten- or eleven-year-old levels. At the two-year-old level, for example, the child is required to identify objects in terms of their use, such as a shoe, a knife, or a table. Another item requires the repetition of two digits. At the three-year-old level repetition of digits is also required but the number is increased to three. Some performance items are essentially the same, but most of them are more complex. At the ten-year-old level memory is also measured by the repetition of digits, but at this age six digits are used. In addition, memory is measured by the ability of the child to recall a number of items of a short story. Not only rote memory is measured but also comprehension and knowledge of relationships. The definition of words is used at several age levels, but with increasing age the words require more abstract mental activity. For example, at the eleven-year-old level, the vocabulary list includes a number of abstract words, such as compare, conquer, obedience, and revenge. The increasing importance of abstract concepts as criteria of intelligence is illustrated by the items in year eleven which require the child to understand the similarities among three objects, such as a rose, potato, and tree. He no longer can simply compare two objects according to their common use, but is now required to generalize conceptually about a number of objects. Investigations have shown that a child's performance on vocabulary tests correlates highly with his general intelligence. Although specific training may give a child a knowledge of vocabulary disproportionate to his general intelligence, the high correlation is usually due essentially to the fact that the vocabulary level reflects the level of symbolism.

The test most commonly used for children of school age is the Stanford Revision of the Binet-Simon Scale. The last revision in which two forms were developed was made in 1937. There is no essential difference in the construction of the two tests nor in the items at each level. The standardization was improved, and the tests have been extended to the two-year-old level and to the superior adult level. There are more items at some of the age levels and a more equitable increase in difficulty from the lowest to the highest. The two-year-old level has 12 items, that is, one item for each month. As many psychologists have shown, the greater the number of items the greater the probable accuracy of a test because an accidental success or failure neither penalizes nor gives the child an undeserved advantage. Because of the necessary use of tests involving knowledge of objects, such as parts of the body or common household objects at the two-year-old level, the possibilities of direct and indirect coaching are great. For instance, item 5 on the 2- to 2½-year-old level requires the child to identify from a picture such objects as a shoe, clock, and a chair. It is obvious that coaching may allow a child to identify these objects in spite of his lack of insight. The 1937 Stanford Revision contains 12 items for the two-, three-, and four-year levels, and 6 for the five- through fourteen-year levels. Above the fourteen-year-old level the test is divided into the average adult, containing eight items, and superior adult I, II, and III, each containing 6 items. This revision adequately meets many of the requirements of a good intelligence test. It contains items involving different mental processes. It attempts to measure the same mental processes at each age level but at a different degree of difficulty. This meets one of the criticisms of intelligence testing, that is, that many tests do not measure the same mental processes at one age level as they do at another. Data regarding the adequacy of this new revision have not been collected in sufficient quantity to warrant definite conclusions regarding its complete adequacy. There are enough data, however, to show that it has a better predictive value than the previous revision and that it is probably the best general intelligence test in use. The recent data which appear to show that the I.Q. is inconstant, especially as it

is influenced by environmental deprivation or an exceptionally good environment, do not detract from the value of this test. Indeed, the rapid changes of I.Q. which have been reported as the result of the influence of different types of environments do not indicate an inconstancy of intellectual capacity or the inadequacy of tests but rather that the environmental conditions and previous training were not properly weighted. For example, a child who has never been exposed to pictures or play materials would naturally not be able to succeed on some tests in the Stanford-Binet scale. This does not mean, however, that the test itself is faulty but rather that the child has not had the opportunity to express his intelligence in the normal way. Because environmental influences may determine performance, and thus measurability, many psychologists believe that intelligence tests should attempt to measure capacity in such a way that performance should not be influenced by the environment.

A number of tests for children who have just entered school have been developed and are known as "primary" tests. Some of these are essentially language tests whereas others are of the nonlanguage type. It is usually better to use nonlanguage tests for young children because of the wide differences in schooling and language training. The Haggerty,¹² the Detroit Kindergarten,¹³ and the Pintner-Cunningham¹⁴ performance scales are the most commonly used of the primary tests.

Nonverbal and nonlanguage tests for older children have also been devised. These tests are especially valuable for children with some language handicap other than that caused by an intelligence defect. One of the best examples of this type of test is the Chicago Non-Verbal Examination,¹⁵ developed and standardized by Andrew Brown of the Institute for Juvenile Research. It is essentially a performance test but has been standarized and validated in comparison with general intelligence

¹² M. E. Haggerty, Intelligence examination, 1920, Yonkers-on-Hudson, World Book Co.

¹³ H. J. Baker and H. J. Kaufmann, Detroit kindergarten test, 1922, Yonkers-on-Hudson, World Book Co.

¹⁴ R. Pintner and B. V. Cunningham, Pintner-Cunningham primary mental test, 1923, Yonkers-on-Hudson, World Book Co.

¹⁵ A. W. Brown, Chicago non-verbal examination, 1936, Chicago, Institute for Juvenile Research.

tests. In one of the tests of the scale the child's ability to learn a group of symbols is measured. He is then required to complete the numbering of a series of symbols. In another test the child differentiates between drawings, one of which differs from the others. In a third test the child is required to calculate the number of blocks which make up different geometrical forms. The fourth test involves the interpretation of geometrical forms. In most of the tests the child is required to describe by his performance his interpretation of relationships. Thus, although it is a nonlanguage and nonverbal test, it nevertheless measures concepts and the knowledge of direct and abstract relationships.

An age-scale test is likely to introduce many errors because the items are graded according to complete success or complete failure. On a point scale partial successes can be scored, and this gives a more accurate estimate of intelligence. The standardization and validation are also supposedly more accurate in the point-scale test. Unfortunately, however, the scores attained on point scales are usually evaluated in terms of mental-age levels. Thus, the final interpretation of a point scale is similar to the interpretation made on an age scale.¹⁶

The work of David Wechsler has been outstanding in the field of intelligence. In 1939 he published the results of his investigation on the measurement of adult intelligence.¹⁷ He pointed out the difficulty in the measurement of adult intelligence, especially in view of the fact that a number of the tests which are used for adults have not been well standardized. In addition much of the usual test material does not adequately motivate adults, and speed rather than comprehension is frequently emphasized.

Wechsler standardized his tests on 670 subjects from seven to sixteen years of age, and on 1,081 from seventeen to seventy years. In addition he examined a large number of cases for his

¹⁶ R. M. Yerkes, J. W. Bridges, and R. S. Hardwick, *A point scale for measuring mental ability*, 1915, Baltimore, Warwick & York, Inc.; R. M. Yerkes and J. C. Foster, *A point scale for measuring mental ability*, 1923, Baltimore, Warwick & York, Inc.

¹⁷ D. Wechsler, *The measurement of adult intelligence*, 1939, Baltimore, The Williams & Wilkins Co.

sampling technique. After a great deal of preliminary work, the following tests were chosen for standardization:

1. An information test
2. A general comprehension test
3. A combined memory span test for digits forward and backward
4. A similarities test
5. An arithmetical reasoning test
6. A picture arrangement test
7. A picture completion test
8. A block design test
9. An object assembly test
10. A digit symbol test

Alternate—A vocabulary test

These were then combined to form the following four separate but interrelated intelligence scales:

The main Individual Adult Examinations for ages sixteen to sixty, consisting of the first ten tests listed, but permitting a reduction of the number to as few as seven, depending upon their suitability to the subject.

An Adolescent Scale for ages ten to sixteen, consisting of the same tests but separately standardized.

A Performance Scale consisting of five tests (tests 6 to 10, inclusive).

A Verbal Scale consisting of five or six tests (tests 1 to 5 and the Vocabulary as alternate).

Wechsler fulfilled an important need because most tests for adults are essentially group tests, and it is well known that group tests are often unreliable. The material in Wechsler's tests is interesting, and the score in terms of points allows for accurate comparisons of individuals.

Group Tests

Group testing was first developed because of the necessity of testing large numbers of people in the shortest possible time. The majority of group tests are of the verbal type, in which

verbal directions, either oral or written, are given, and the individual responds by writing or checking. They are nearly all speed tests, that is, the score depends upon the successful completion of the items of the test in a given length of time. For the most part they are designed for high-school-age children and adults. The following are the common types of material contained in these tests: opposites, analogies, reasoning, arrangement of disarranged sentences, proverbs, number completion, following directions, sentence completion, general and specific information, arithmetical performance and reasoning, word knowledge, generalization ability, and symbol and picture completion. Because of the factors of training and formal education these tests have been called mental alertness rather than intelligence tests. An individual who has had training in answering questions quickly generally makes a higher score. The best-known example of an alertness test for adults is the Army Alpha¹⁸ which was developed during the first World War. It consists of eight tests, totaling 212 items. Test 1 measures the ability of the individual to follow specific directions. Test 2 measures arithmetical ability. Test 3 consists of "common sense" items. Test 4 is a measure of vocabulary knowledge. Test 5 contains 24 disarranged sentences. Test 6 measures number completion ability. Test 7 is a test of relationship. Test 8 measures general information. In spite of the criticisms by many psychologists that education and training determine the score an individual obtains, the test has been used successfully since its publication and has been valuable for predictive purposes. The Army Beta test was designed for the same purpose but is a nonlanguage, nonverbal test in which symbols are used. The test was devised mainly for those who were unable to read or write either because of deficient schooling or because they were recent immigrants.

One of the most widely used group tests is the Otis self-administering test of mental ability,¹⁹ which is designed for the intermediate and higher levels. The higher examination con-

¹⁸ C. S. Yoakum and R. M. Yerkes, *Army mental tests*, 1920, New York, Henry Holt & Co.

¹⁹ A. S. Otis, *Otis self-administering tests of mental ability*, 1922, Yonkers-on-Hudson, World Book Co.

tains 75 items supposedly arranged in rank order of difficulty. Either a 20- or 30-minute period is allowed, and the score is obtained from the number of items completed successfully. The Otis tests have been found to correlate highly with other criteria of intelligence and are used extensively for the examination of high-school and college students. The only serious difficulty in such tests is the inability of some persons to work independently. Another well-known test is the Terman group test of mental ability.²⁰ The items include information, word meaning, logical selection, arithmetic problems, sentence meaning, analogies, mixed sentences, and number series. The American Council on Education psychological examination²¹ has been used extensively for high-school and college students. It has been used for the selection of incoming college students, and the correlation between the scores on this test and academic success has been found to be high. The National Intelligence Test²² has been used in many schools where an accurate and convenient method of group testing was required. It has been well standardized on a large number of children and has been shown to be reliable and academically predictive.

Performance Tests

There are a large number of individual as well as batteries of performance tests designed to measure the intelligence of a child. They are used effectively when tests which require language responses cannot be used. The Porteus maze test was developed by S. D. Porteus.²³ It has been used as a single test and as part of batteries of tests. It consists of a series of printed mazes from the simple single-direction type to the complicated type which contains many blind alleys. It has been shown to measure mental processes which general intelligence tests measure, and is not directly related to specific sensori-

²⁰ L. M. Terman, Terman group test of mental ability, 1920, Yonkers-on-Hudson, World Book Co.

²¹ L. L. Thurstone, Psychological examination for high school graduates and college freshmen, 1935, Washington, D. C., American Council on Education.

²² National intelligence tests, 1924, Yonkers-on-Hudson, World Book Co.

²³ S. D. Porteus, The measurement of intelligence: Six hundred and fifty-three children examined by the Binet and Porteus tests, *Journal of Educational Psychology*, 1918, 9, 13-31.

motor adequacy, although a child with a motor disturbance cannot perform well on this test. The test has been standardized for ages three to fourteen. The score is computed on the basis of the highest test passed after deduction of a year for each lower test failed, and a half-year for each lower test which is passed on the second trial.

The Goodenough test of the drawing of a man²⁴ was developed by Florence Goodenough of the University of Minnesota. The examiner simply asks the child to draw a man. If the child has not had specific training in drawing and if he has no sensory or motor defects, the results give a fair measure of his intelligence. The drawing is scored according to the items that are attached to the body or separate), nose, number of fingers, clothing, and so on. The test is particularly valuable for children who are deaf or who are unable to understand even the simple directions of ordinary nonverbal tests. Mental ages from three to fourteen can be computed. In spite of its simplicity and the possibility that success or failure may be influenced by motor defects or by specific training in art or drawing, psychologists who have used this test have reported favorably. It has not been used as frequently as general intelligence tests, partly because it does not reveal as much about a child's intelligence as the other types of tests, and partly because most psychologists are somewhat dubious about the results obtained from a single test item. As mentioned previously, performance tests are frequently ways through which general comprehension and concepts can be measured. To a large extent this is probably also true of the Goodenough test. The drawing of a man does not involve only the ability of a child to draw, but also his comprehension of the various parts and his understanding of relationships. The Kohs block design test²⁵ is a somewhat more complicated method of testing the intellectual performance of an individual by his ability to build color designs from sixteen colored cubes after he is shown a printed picture of a given

²⁴ F. L. Goodenough, *Measurement of intelligence by drawings*, 1926, Yonkers-on-Hudson, World Book Co.

²⁵ S. C. Kohs, *Intelligence measurement*, 1923, New York, The Macmillan Co.

design. The test has been found to correlate highly with general intelligence tests and, according to Kohs, measures the higher intellectual processes rather than mere performance or special ability. The Grace Arthur performance scale²⁶ has been used extensively especially in conjunction with general intelligence tests. It is made up of ten performance items, eight of which make up the Pintner-Paterson series.²⁷ The scale includes the Knox cube,²⁸ Seguin form board, the two forms of the Healy picture-completion test, the Porteus maze, and the Kohs block design tests. The scale has been found to correlate highly with general intelligence tests and is frequently used as a means of determining the validity of a verbal test. For example, if the score on the Grace Arthur is very much higher or lower than on a general intelligence test, the reliability of the general intelligence test may be questioned. In many instances a child who has had poor academic training or has a defect which is not easily ascertained will score on a much higher level on this scale than on the usual verbal and language test. There are a number of other performance scales. In general, they have been standardized in the same way as the Grace Arthur and the Porteus Maze scales and are employed in cases where the general intelligence test cannot be used adequately. An examination of children with sensory handicaps may be made by use of performance tests. In the case of the blind it is easier to use adaptations of general intelligence tests in which the directions can be given verbally and the responses may also be verbal. The Hayes²⁹ adaptation of the Stanford-Binet is the best known of the special scales for persons who are blind. It consists of six tests at each year level from three to ten, and eight tests at years fourteen, sixteen, and eighteen. The Columbus point scale for the blind³⁰ was developed by T. H. Haines. It is essentially a

²⁶ G. Arthur, A point scale of performance tests, Vol. I, 1930, New York, Commonwealth Fund.

²⁷ R. Pintner and D. G. Paterson, A scale of performance tests, 1917, New York, D. Appleton-Century Co., Inc.

²⁸ H. A. Knox, A scale, based on the work at Ellis Island, for estimating mental defect, *Journal of American Medical Association*, 1914, 62, 741-747.

²⁹ S. P. Hayes, Revision of the Stanford-Binet intelligence tests for the blind, 1930, South Hadley, S. P. Hayes, Mount Holyoke College.

³⁰ T. H. Haines, Mental measurements of the blind, *Psychological Monographs*, 1916, 21, No. 1.

revision of the Yerkes-Bridges point scale. The tests in which vision is essential were eliminated and other tests substituted.

Very few special tests have been developed for the deaf. In most cases performance scales of the type used for other children are employed for the measurement of the intelligence of deaf children. The Pintner-Paterson scale, the Porteus maze, the Drever-Collins performance scale,³¹ and the Grace Arthur performance scale are most commonly used. In general, it has been found that the scores of deaf and blind children are somewhat lower than the scores of normal children. This is considered to be due to the lack of experience and the difficulty involved in the administration of the tests.

Aptitude Testing

In recent years aptitude testing has become popular principally for the purpose of vocational guidance. The first systematic attempt to develop aptitude tests was made for the purpose of measuring mechanical ability. An aptitude test measures the capacity to acquire a given skill. Most psychologists believe that many of the recent aptitude tests which have attempted to measure general abilities rather than special ability are in reality either modified intelligence tests or achievement tests, that is, measures of previous experience and training. For example, a scholastic aptitude test for medical students³² was developed by F. A. Moss, of George Washington University. It is an attempt to measure the ability of a student to complete successfully a medical course and has been used extensively in the selection of students for admission to medical schools. The test measures scientific vocabulary, visual memory, memory for descriptive material, premedical information, retention of material, following directions, logical reasoning, spelling of terms, and understanding of printed material. The reports of the follow-up of students have shown a high correlation between the scores on this test and their success as medical students and as interns.

³¹ J. Drever and M. Collins, *Performance tests of intelligence*, 1936, Edinburgh, Oliver & Boyd.

³² F. A. Moss, *Scholastic aptitude test for medical schools*, 1927, Washington, D. C., Center for Psychological Service.

There is no doubt that this test has proved successful from the standpoint of selection of students, but the theoretical problem arises as to whether it is really an aptitude test or whether it is a test involving a measure of intelligence and of special information which is important for success in medical school. Aptitude implies special ability, and the question therefore arises whether success in medical training is determined by special ability or whether it is determined by general intelligence, interest, and premedical training.

The most important of the mechanical aptitude tests are the Stenquist assembly and pictorial tests,³³ the Minnesota mechanical ability tests,³⁴ the MacQuarrie test for mechanical ability,³⁵ and the O'Rourke mechanical aptitude test.³⁶ The Stenquist assembly test consists of a number of common objects which are disassembled and the child is required to assemble them within a given time. It is scored according to the speed and accuracy of the assemblies. Some of the objects are a clothespin, a mouse trap, a bicycle bell, and a lock. The pictorial test consists of a number of objects which the subject is required to relate to another series of objects. The objects depicted are common mechanical types. The pictorial method is probably more reliable than the performance method, because it does not depend as much upon previous experience with mechanical devices. The Minnesota mechanical ability tests were developed by Paterson and Elliott of the University of Minnesota. This test is constructed in the same way as the Stenquist, consisting of common objects which the subject assembles. In addition, a paper form board is used, and a test of spatial relations is included.

There are also large numbers of other aptitude tests for predictive measurement in varied fields. There are aptitude tests for clerical ability, for special academic subjects, for typing, for telegraphy, and for ability in art.

³³ J. L. Stenquist, *Measurements of mechanical ability*, 1923, New York, Teachers College, Columbia University.

³⁴ D. G. Paterson and R. M. Elliott, *Minnesota mechanical ability tests*, 1930, Minneapolis, University of Minnesota Press.

³⁵ T. W. MacQuarrie, *MacQuarrie test for mechanical ability*, 1925, Los Angeles, Southern California School Book Depository.

³⁶ L. J. O'Rourke, *O'Rourke mechanical aptitude test*, 1927, Washington, D. C., Educational & Personnel Publ. Co.

Achievement Tests

Achievement tests measure the degree of accomplishment. Although the scores on many achievement tests depend upon intelligence, capacity, and previous training, they are essentially measures of accomplishment. For instance, a child with an I.Q. of 120 may show a low achievement score on a given area compared with a child of similar age with an I.Q. of 100 or lower. In general, the achievement level usually does not rise above the level of intelligence but in many cases it may be higher than in persons of higher intelligence. The most common use of achievement testing has been made by school administrators for the grade placement of children. Many achievement tests attempt to measure a wide range of school subjects, whereas others attempt to measure only special fields, such as achievement in reading, in chemistry, or in arithmetic. The Stanford Achievement Test³⁷ is used extensively for evaluating the school achievement of children, especially for comparison with their intelligence scores. There are a number of items, and they attempt to measure various combinations of abilities. The advanced examination, for example, consists of paragraph meaning and reading, word meaning, reading from dictation, language use, literature, history and civics, geography, physiology and hygiene, arithmetical reasoning, and arithmetical computation. A profile of the child is obtained from which decisions regarding placement can be made. The educational quotient can be compared with the intelligence quotient in order to discover whether the child is working at his best capacity and in which area he is working poorly or well. The Metropolitan achievement test³⁸ consists of different forms and different tests for various grades. For grades 4 to 6 and grades 7 and 8 there are nine tests. For grade 1, there are four tests. For grades 4 to 8 the tests measure achievement in reading, vocabulary, arithmetic fundamentals and problems, English, literature, history and civics, geography, and spelling. Because of the large number of

³⁷ T. L. Kelley, G. M. Ruch, and L. M. Terman, New Stanford achievement test, 1929, Yonkers-on-Hudson, World Book Co.

³⁸ R. D. Allen, H. H. Bixler, W. L. Connor, and F. B. Graham, Metropolitan achievement tests, 1935, Yonkers-on-Hudson, World Book Co.

items and because of the careful standardization by the authors, it has been used extensively in many school systems. The lower-grade forms have also been used for measuring the achievement of children who have not had adequate formal schooling.

Achievement tests must be evaluated carefully in the interpretation of the intellectual capacity of children. It has been observed that retarded children may achieve much more than is expected of them because of diligence and perseverance. When the achievement of a child is more than is expected of him from the scores on intelligence tests, the recommendation is usually made that attention should be directed toward the development of those achievements below his capacity. Sometimes an achievement test can be used with profit when a general intelligence test cannot be given properly. This is observed in cases in which a child is uncooperative on general tests but may be highly cooperative in tasks which are of great interest to him.³⁹

³⁹ For a brief but excellent description of various types of tests see F. N. Freeman, *Mental tests*, 1939 (rev.), Boston, Houghton Mifflin Co.

Chapter 13

THE ADJUSTMENT OF THE DEFECTIVE

Social and Vocational Adjustment

Adjustment of mental defectives in a normal society depends upon a variety of factors in addition to the degree of mental retardation. In many instances children are committed to public institutions, not primarily because of a mental defect, but because they have been found socially unfit due to antisocial or delinquent behavior. The economic condition of a family also determines whether or not a child will be sent to an institution. In times of economic stress, when occupational adjustment is difficult for all people, the defective individual finds it even more difficult to adjust. Another factor which affects commitment to an institution is the nature of the individual's environment. Defective children find it much more difficult to adjust socially and vocationally in urban centers than in rural areas. Parents are also generally more sensitive about their mentally deficient children in a city than in the country. Thus there is more pressure put upon city parents to place their mentally deficient children in institutions.

In general, children who have an I.Q. of less than 50 cannot adjust without a great deal of supervision, and are often institutionalized. Those with I.Q.'s over 60 can adjust with fair effectiveness when they are well supervised, and especially when they have been trained vocationally.

Feeble-mindedness and mental retardation are not directly associated with social incompetence in a cause-and-effect relationship. Persons of high intelligence may be socially incompetent either because of emotional or personality disturbances. Those who have no distinctive signs of mental deficiency, such as are found in the Mongolian idiot, are more likely to make an

adjustment in normal society than those with physical or other characteristics which make them easily recognizable. The personality characteristics of the defective person are extremely important in determining his adjustment in a normal society or his commitment to an institution. The defective child who readily becomes emotionally upset is much more likely to be committed to an institution than a child with the same I.Q. who is emotionally stable. A defective child who is industrious and has a stable personality can usually make a good adjustment in a normal society if his intelligence is not extremely low.

A number of investigations have been made of the adjustment of mentally defective persons in various situations. Bronner,¹ for example, studied 189 defective delinquents who were examined in a psychiatric clinic. As a criterion of social adjustment, Bronner evaluated the behavior of the individuals in terms of the amount of annoyance and trouble they caused. She found that about 54 per cent made a successful adjustment, about 25 per cent were considered to be in a doubtful category, and 21 per cent were failures. She found that the racial and home backgrounds were not the most important factors. The quality and the amount of supervision and the personality characteristics of these individuals were the most important factors determining success or failure. The degree of retardation is normally not the most important factor in determining the success of the adjustment. Children with I.Q.'s of 75 may adjust less successfully than children with I.Q.'s of 60. This was indicated in the report by Kinder and Rutherford.² They showed that many of the adjustment failures of retarded children were the result of poor home backgrounds and social and economic disintegration. The same conclusion was reached by Lurie and his co-workers.³ In their series of cases they found that the best adjustments were made by children with I.Q.'s of from 50 to

¹ A. F. Bronner, Follow-up studies of mental defectives, *Proceedings of the American Association on Mental Deficiency*, 1933, 57, 258-267.

² E. F. Kinder and E. J. Rutherford, Social adjustment of retarded children, *Mental Hygiene*, 1927, 11, 811-833.

³ L. A. Lurie, A. Schlan, and M. Freiburg, A critical analysis of the progress of fifty-five feeble-minded children over a period of eight years, *American Journal of Orthopsychiatry*, 1932, 2, 58-69; L. Hay and B. Kappenburg, Social adjustment of children of low intelligence, Part III, *Smith College Studies in Social Work*, 1931, 2, 146-174.

approximately 60. About 70 per cent were gainfully employed; 40 per cent of the girls worked in factories.

TABLE 17
INTELLIGENCE QUOTIENT AND SOCIAL ADJUSTMENT
(From Lurie, Schlan, and Freiburg, p. 63)

Intelligence Quotient	Total	Adjusted	Partially Adjusted	Unadjusted
Borderline	70-80	15	7	5
High-grade moron.....	63-69	19	8	5
Middle-grade moron.....	58-62	11	8	2
Low-grade moron.....	50-58	5	5	1
Imbecile	25-50	4	4	..
Idiot	0-25	1	1	..
Total	55	33	13	9

Results of Institutional Treatment

A number of careful studies have been made of children who had been in institutions for mental defectives and were paroled or discharged for various reasons. It is obvious, however, that children who are paroled are usually better qualified to adjust because they have been treated for their abnormalities or defects. Also, parole or discharge is usually made on the basis that the parents or some agency will take responsibility for supervision. Fernald⁴ investigated 646 individuals who were discharged from the Waverly State School on the recommendation of the officials of the institution. Of this group, 181 made a satisfactory adjustment. Another group made a good adjustment principally because they were supervised and supported by their parents or relatives. This report was important because defective children had previously been kept in institutions indefinitely, and therefore many who needed care could not be accommodated. In 1922 a report by Matthews⁵ of 100 boys paroled from Waverly again supported the previous findings that a

⁴ W. E. Fernald, After-care study of the patients discharged from Waverly for a period of twenty-five years, *Ungraded*, 1919, 5, 26-31.

⁵ M. A. Matthews, One hundred institutionally trained male defectives in the community under supervision, *Mental Hygiene*, 1922, 6, 332-342.

relatively large number of treated children are able to adjust adequately. One of the most optimistic reports was made by Storrs,⁶ who stated that about 72 per cent of those discharged from Letchworth Village made a successful adjustment.

Examinations of the studies of the adjustment of defective individuals in normal society show that many investigators were probably too optimistic and did not take into account a number of factors which made the adjustment of the defective child in his own home relatively easy. The investigators did not sufficiently take into account the fact that parents protect their defective children much more than their normal children. They do not have to compete vocationally and they do not need to be financially self-supporting.

In spite of the large number of reports on the nature of the social adjustment of defective children, the criteria of social success have not been specifically evaluated. A social adjustment which is considered successful by one investigator may be considered unsuccessful by another. The investigations of Doll⁷ have emphasized the social success of mentally deficient individuals. In a report in 1931 he stated that over 50 per cent made a successful adjustment although a number of these children had been discharged from the Vineland Training School against the advice of the staff. The investigations of Penrose have been directed toward the study of vocational as well as social adjustment. The following table⁸ of the data of one of the studies of Penrose shows that a large number of those on parole from an institution for the feeble-minded were not only adjusted socially but also made an adequate vocational adjustment.

Approximately only 5 per cent of those who have been in institutions readjust themselves in the community on an adequate economic and social level without direct supervision. Approximately 20 per cent of those who are supervised readjust themselves adequately and are able to take care of themselves

⁶ J. C. Storrs, A report on an investigation made of cases discharged from Letchworth Village, *Proceedings of the American Association on Mental Deficiency*, 1934, 58, 220-232.

⁷ E. A. Doll, Parole of the feeble-minded, *The Training School Bulletin*, 1931, 28, 1-10.

⁸ L. S. Penrose, Mental defect, 1934, New York, Farrar & Rinehart, p. 160.

economically. A relatively large number are able to engage in some productive work but not to a degree sufficient for adequate economic maintenance. Some of the individuals who have been in state institutions make inadequate vocational adjustments but without creating social difficulties. In general, therefore, approximately 50 per cent may be safely sent out of the institutions, but the majority require some supervision. Some surveys have shown that mentally deficient individuals who have good work habits and who have learned a simple skill have had earning capacities equal to normal individuals with a long work record.

TABLE 18
REPORT OF CASES ON LICENSE UNDER THE CARE OF THE
ROYAL EASTERN COUNTIES INSTITUTION, 1932
(From Penrose, p. 160)

	Males	Females	Total
Wage earning	28	22	50
Working, not earning	13	34	47
Not able to work.....	4	7	11
In Public Assistance Institution.....	3	18	21
Total	48	81	129
Total population of Institution..	842	585	1,427

Mention has already been made of the fact that commitment to a school for defectives is often based primarily upon factors other than intellectual retardation. For this reason it is important to know what adjustment mental defectives make when they are not sent to an institution. Data on this problem have been obtained by studying children who attend special classes in the public schools. The frequency of adjustment of the retarded and defective individuals who attend special classes is in almost all instances greater than that of those who have been in institutions. This is due primarily to the fact that the lower types of mental defectives are sent to institutions.

An interesting follow-up study was made by Steckel.⁹ She

⁹ M. L. Steckel, A "follow-up" of mentally defective girls, *Journal of Social Psychology*, 1934, 5, 112-115.

investigated the careers of 100 girls who had been in special classes from the ages of twelve to sixteen. The I.Q.'s of these girls ranged from 44 to 70. At the time of the investigation they had been out of school for from one to ten years. Only 19 of the 100 girls were gainfully employed outside of their homes, and a number had attempted occupational adjustment without success. Steckel concluded that one of the factors in their failures was the poor home background and the inability of the relatives to give them close supervision. A similar follow-up study was made by Thomas,¹⁰ who investigated the pupils who left special classes after a five-year period. Thomas found that the majority of the girls had factory jobs and that the turnover of jobs was relatively large. Their adjustment varied, but in general Thomas found that their personality difficulties were due to improper school training. The Children's Bureau¹¹ made a study of 949 former special-class pupils in seven towns. The I.Q.'s of these children ranged from 50 to 70. Approximately 90 per cent had had employment during the years following their school attendance, and 61 per cent were gainfully employed at the time this study was made. Less than 5 per cent of this group were under supervision. In other follow-up studies it has generally been found that approximately 20 per cent are employed, and only a small percentage are seriously maladjusted.¹²

The occupational adjustment of children who had been in special classes in public schools is similar to that of individuals who are discharged from schools for the feeble-minded. In general, however, children from special classes in public schools adjust themselves better. In part this may be due to their more stable personalities, because the unstable defective is more likely to be sent to a state school. In a survey of these children it was found that 70 per cent of the boys and 56 per cent of the girls

¹⁰ H. P. Thomas, *The employment history of auxiliary pupils between sixteen and twenty-one years of age in Springfield, Massachusetts*, *Proceedings of the American Association for the Study of the Feeble-minded*, 1923, 52, 132-148.

¹¹ A. Channing, *The employment of mentally deficient boys and girls*, U. S. Children's Bureau, 1932, Washington, D. C., Government Printing Office.

¹² See M. E. Bryne, Editor, *A study of post-school adjustment of boys and girls of special classes*, 1930, Minneapolis, Department of Special Education (mimeographed).

found work within a short time after leaving school. The important difference between these individuals and an unselected group is that the defectives did not stay at any one job for a long period. Seventy-four per cent of the boys, however, held one position for at least one year, and 37 per cent held one job for at least two years. The majority did unskilled or semi-skilled work for which little training was required. A few did learn a trade, and a very small number became storekeepers. When they attempted to do office work, they were generally unsuccessful, however. The individuals with the higher I.Q.'s selected a wider range of occupations and had a higher income. The specific training which retarded and defective children had during their schooling was generally not directly related to their jobs when they left school.

TABLE 19
PER CENT OF THE 2,755 POSITIONS HELD WHICH FALL IN EACH GROUP
OF THE OCCUPATIONAL SCALE
(From Keys and Nathan, p. 508)

Occupational Group	Males	Females	Total
Professional, etc.	0.0	0.0	0.0
Semi-professional, managerial, and commercial etc.	0.0	0.0	0.0
Small shop or farm owners, foremen, clerks, etc.	1.1	2.7	1.9
Skilled laborers	11.2	4.8	8.0
Unskilled laborers	79.5	84.4	82.0
Unspecified employment	8.2	8.1	8.1
Total	100.0	100.0	100.0

In a review of a number of studies on the adjustment of retarded and defective persons, Keys and Nathan¹³ showed that less than 2 per cent were employed as small shop or farm owners, foremen, or clerks; about 8 per cent were employed as skilled laborers, and the remainder as unskilled workers. They believed that it is questionable whether the kind of vocational training given in a public school is of direct value for their

¹³ N. Keys and J. N. Nathan, Occupations for the mentally handicapped, *Journal of Applied Psychology*, 1932, 16, 497-511.

occupational adjustment. They suggested that socialization, development of motor control, enlargement of vocabulary, and improvement of personality are the areas in which the public schools should be interested.

Reports of vocational counselors have shown that persons with relatively low I.Q.'s may make excellent vocational adjustments. For example, Burr¹⁴ has shown that a minimum mental age of only six years was required for nineteen types of jobs. A number of kinds of work are adequately performed by persons with mental ages of eight to eleven. The work situation of an individual cannot be used, however, as a criterion of social adequacy. For example, some investigators have reported that their surveys indicate that the unstable defective boy has more work opportunities than the unstable defective girl. Jobs which require little initiative and which do not necessitate changes in tempo are found to be less difficult for defective individuals than those in which they must assume responsibility. Burr¹⁵ studied a group of 375 girls who were mental defectives or borderline defectives, in order to determine whether they had been successful in vocational adjustment when supervised. These girls were under the supervision of a vocational bureau and therefore a complete history and follow-up were made. It was found that a factory job involving little ingenuity or variation was the best type of vocational activity to which these individuals became adjusted. In many instances the emotional factors were much more important in causing maladjustment than the degree of mental deficiency. For example, in the high-grade moron group a large number of personality difficulties were reported as a factor in their vocational maladjustments. The steady, lethargic individual was more successful in industry than the restless, unstable person even though the latter was of higher intelligence. The minimum intellectual level at which a girl was able to adjust herself in an industrial occupation was found to be between six and seven years.

¹⁴ E. T. Burr, Minimum intellectual levels of accomplishment in industry, *Journal of Personnel Research*, 1924-25, 3, 207-212.
¹⁵ E. T. Burr, The vocational adjustment of mental defectives, *Psychological Clinic*, 1931, 20, 55-64.

Institutional Care

Organized care of defective children in institutions has been carried on only in relatively recent years. In spite of the increasing belief that defectives can be treated effectively, most state institutions are designed principally for custodial care rather than therapy. Probably the first systematic attempt to train a low-grade defective was made by Itard,¹⁶ whose story of the education of the wild boy of Aveyron was widely publicized. Although his attempt was not successful, it nevertheless focused public attention upon the possibility of educating mentally abnormal and defective persons. At that time mental deficiency was considered a disease and not as a lack of capacity. Credit generally is given to Edwin Seguin for the first systematic evaluation of mental deficiency. He was the first to define a number of forms of deficiency in terms of arrested mental development rather than pathology. Seguin recognized the possibility of the development of many useful habits by various types of sensori-motor training. He believed that he was able to develop imperfect sense organs. Obviously, Seguin did not develop the sense organs but rather established habits which aided the children in adjusting themselves. When Seguin came to the United States from France, he became active in organizing institutions for defective children for therapy rather than custody. In Germany there was also a concerted movement during the nineteenth century for the development of training institutions for the feebleminded. In 1845 Germany passed a number of laws regarding the care of the mentally deficient. These laws were constantly amended, and it is generally considered that the one passed in 1913 instituted one of the most comprehensive systems for the guardianship and custody of the mentally deficient.

In this country the first private school was established in Barre, Massachusetts, in 1848, by Harvey Wilbur. In the same year, Massachusetts established the first state institution. Today there are approximately 60 state institutions for the men-

¹⁶ J. M. G. Itard, *The wild boy of Aveyron* (trans. by G. and M. Humphrey), 1932, New York, D. Appleton-Century Co., Inc.

tally deficient, and only four states do not have any established institution under state control. There is no central organization for the study of the mentally defective and each state has its own laws and its own methods of recognition and treatment. The work of scientific organizations such as the American Association on Mental Deficiency has been very important in the dissemination of information regarding the problems of the mentally deficient. Although approximately 3 per cent of the population is definitely defective, the number of children in custodial institutions is relatively small.

The problem of institutionalization is difficult to evaluate, largely because social adjustment in the community depends in a great measure upon the resources of the family, the amount of supervision which the individual receives, and the prevailing attitudes. In most states facilities exist for only a small percentage of the children in need of some form of institutional treatment. The general attitude is that children are sent to institutions only when the family is unable to care for them or when they disturb the community.

Only a few public or private agencies have attempted to develop a comprehensive program for the social orientation of defective individuals, either those who are graduates of special classes or those who have been discharged from state institutions. In recent years South Dakota has instituted a new program for the social control of feeble-mindedness. Its primary purpose is to provide for the identification of defectives throughout the state. Systematic supervision was also instituted. As the result of the close supervision, over 90 per cent of the feeble-minded were not dispossessed of their rights as citizens. A central state committee and special committees in each county collect data, administer tests, consult with schools and parents, and supervise the vocational and social adjustment of the defectives. In other states there is little centralization of authority and very little organization designed to help these individuals. Commitment to an institution or sterilization have been the common means of control in many states.

Chapter 14

SOME GENETIC PROBLEMS

Mental deficiency has been considered by some investigators as a recessive characteristic, that is, that the inheritance of less than normal mental capacity is due to a germ plasm deficiency. The implication that intelligence is a unit character of inheritance has been denied by many geneticists. Most investigators believe that the inheritance of intelligence involves a complex pattern of inheritable qualities and therefore cannot be treated as if it followed a simple mode of inheritance. The statistical data on the frequency of mental deficiency in given families have shown that intelligence cannot be considered to be a unit character of inheritance. This conclusion has been reached in spite of the findings as the result of a number of investigations, such as of the Kallikak and Juke families. No exact psychological methods were used in those investigations, and interpretive conclusions were made on the basis of social rather than psychological data.

The recent emphasis on sterilization has led to more intensive investigations of the hereditary factors of mental deficiency. In a previous discussion it was shown that amaurotic family idiocy is probably inheritable. This is a condition characterized mainly by physical signs, however, and cannot be evaluated in the same way as those cases which show no organic pathology. Recently studies of phenylpyruvic acid in the urine of mental defectives have created an increased interest in the genetic study of mental deficiency. Jervis¹ found that approximately .5 per cent of 8,043 mental defectives showed positive findings. In normal persons phenylpyruvic acid is never found. Jervis believes that these findings show that there is a trans-

¹ G. A. Jervis, Phenylpyruvic oligophrenia, *Archives of Neurology and Psychiatry*, 1937, 38, 944-963.

mission through a single recessive gene. The essential biochemical feature is the presence of phenylpyruvic acid in the urine. According to Jervis it is apparently due to the failure of the body to deal with phenylpyruvic acid which is derived mainly from the phenylalanine, one of the amino acids. In a later study Jervis² stated that 40 to 80 per cent of mentally defective individuals are determined by genetic mechanisms in which recessive genes play a significant role. He reported a study of 200 cases of mental deficiency known as phenylpyruvic oligophrenia. Most of the patients showed motor signs, such as increased muscle tonus, hyperactivity of the deep reflexes, knee and ankle clonus, and athetoid and choreiform movements. Two-thirds of the cases were at the idiot level and one-third at the imbecile level. He examined 125 families, and found that in 51 families two or more members were affected. Jervis stated that, since phenylpyruvic oligophrenia is rare, mere chance cannot explain the high familial incidence.

Since the character does not appear in successive generations, the hypothesis of a single dominant gene cannot be assumed. Geneticists have shown that certain structural and disease entities are inheritable either as a dominant or as a recessive characteristic, and either as an autosomal or as a sex-linked characteristic. For example, albinism is inherited as an autosomal recessive and polydactylysm as an autosomal dominant. Color blindness and hemophilia are inherited as sex-linked recessives. Claims have also been made regarding the inheritance of such conditions as some types of insanity, ataxia, and susceptibility to given diseases. As mentioned in a previous discussion, the greater similarity of the intelligence of siblings and especially of monozygotic twins than of nonsiblings may illustrate the role of hereditary factors. The evidence is not conclusive, however, because many studies have shown that the environment may produce similarity or dissimilarity independent of family relationships. Studies of human inheritance have not been critical because of the slow rate of propagation and the difficulty of controlling the numerous environmental factors.

² G. A. Jervis, The genetics of phenylpyruvic oligophrenia, *Journal of Mental Science*, 1939, 85, 719-762.

One of the most difficult problems in the study of the hereditary basis of feeble-mindedness is related to the method of transmission of any characteristic. Mohr³ illustrated this in the example of the inheritance of albinism. This condition has an incidence of less than .01 per cent. If sterilization of all albinotic individuals were carried out in every generation, it would require about two thousand years to reduce its incidence to one-half of its present frequency. This, according to Mohr, is a consequence of the fact that heterozygous carriers continue to transmit the gene. In regard to the method of transmission of mental deficiency, Jennings⁴ stated that there are probably 330,000 feeble-minded people in this country carrying two defective genes to the pair, ten million normal carriers with one defective gene to the pair, and ninety million normals having no defective genes. It may therefore be estimated that approximately 11 per cent of the feeble-minded in a generation result from a mating of feeble-minded individuals and 89 per cent from the mating of carriers. Thus, if the feeble-minded were eliminated, the reduction would be no more than 11 per cent in the first generation. If the succeeding feeble-minded individuals were eliminated, the subsequent rates of reduction would be much slower. If carriers could also be identified, the reduction would be much faster but we cannot as yet identify them. Mohr believed that perhaps fifteen million people would have to be sterilized up to 1980, beginning with 100,000 a year and increasing the number to 400,000 annually if significant reductions in mental deficiency are to be obtained. The difficulty of identifying the carriers (providing there are carriers) of mental deficiency is illustrated in the statement of T. H. Morgan.⁵ He stated that man has 48 chromosomes which allow for 282,429,536,481 possible kinds of individuals on the assumption that there are differences in the units of each pair. Identifying individuals for sterilization is therefore complex.

³ O. L. Mohr, *Heredity and disease*, 1934, New York, W. W. Norton & Co., Inc.

⁴ H. S. Jennings, *The biological basis of human nature*, 1930, New York, W. W. Norton & Co., Inc., p. 241.

⁵ T. H. Morgan, *The mechanism and laws of heredity in Foundations of Experimental Psychology* (edited by C. Murchison), 1929, Worcester, Clark University Press, pp. 1-44.

Sterilization was first legalized by the Indiana State Legislature of 1907 and is now sanctioned in 28 states. The results have not been adequately evaluated. Some students of genetics believe that the results have been exceedingly good, whereas others question the value of sterilization except from the standpoint of its social effects. Feeble-minded individuals are frequently at the lower levels of social and economic adjustment, and their inability to care for their children adequately may be a sufficient reason for their sterilization.

As mentioned previously, the nature-nurture controversy has been revived recently in the attempt to evaluate the significant factors which determine intellectual growth. Unfortunately, although a great deal of evidence has been produced in recent years, especially in such studies as those from the University of Iowa, no specific conclusions have been formulated. The experimental method of studying the relative effects of nature and nurture are relatively new. In the past, a common method of study was the evaluation of the genetic history of successful, average, unsuccessful, and pathological persons. Unfortunately, these studies did not produce significant data, principally because the social backgrounds could not be evaluated quantitatively.

Biologists have quite naturally assumed the hereditary viewpoint. Davenport⁶ in 1911 stated that the differences between men are almost entirely due to differences in natural powers and aptitudes, and that, although the environment might in some ways affect the trend of given phases of development, the basic powers can be changed very little by environmental changes. These viewpoints are in direct contradiction to the beliefs of a number of psychologists, especially those who were at one time labeled as behaviorists. John B. Watson is generally credited with having stimulated the type of systematic psychology in which environmental factors were considered the significant basis of most individual differences. Watson and his co-workers presented evidence that the environment plays a significant role in determining the development of a child. Thus, even though they accepted the main tenets of the biologists, they nevertheless

⁶ C. B. Davenport, *Heredity in relation to eugenics*, 1911, New York, Henry Holt & Co.

less showed that environmental differences determined many, if not most, behavioral differences.

Psychologists and geneticists who investigated the nature-nurture problems after Watson's period compromised between the environmental and hereditary viewpoints. They showed that heredity cannot directly determine the various patterns of behavior. They conceded that without specific hereditary factors given forms of behavior would not be possible, but they also pointed out that much of our behavior is affected by environmental conditions and that it is futile to consider either heredity or environment as independent factors. Jennings⁷ also pointed out that one of the chief sources of error in the interpretation of human behavior arose from the misconception of the meaning of unit characteristics. Many biologists at one time believed that each characteristic was in some way represented in one gene. It has been shown, however, that any single gene affects many characteristics. The development of these genes and their function obviously depend upon many conditions within the body, and therefore in a sense upon environment. It is well known that different conditions may produce different results from the same set of genes. Therefore, an individual's specific hereditary history may not be sufficient evidence for the prediction of his development. Jennings objected to the artificial distinction which psychologists frequently make between those characteristics which are supposedly specifically inherited and those which are specifically acquired. This confusion has been amply illustrated in the contradictory results from a number of studies. For example, studies of pathological families illustrate the difficulty of a specific differentiation between social and hereditary factors. The uniformly low intelligence scores of the inhabitants of some isolated and backward areas may well be the result of an environmental lack rather than of an hereditary deficiency.

It is now well known that human traits may differ widely in their reactivity to environmental conditions. Thus, some traits may possess a wide range of variability even under rela-

⁷ H. S. Jennings, *Prometheus; or biology and the advancement of man*, 1927, New York, E. P. Dutton & Co.

tively uniform conditions, whereas others vary little, although the environmental conditions may differ greatly.

One of the best methods of studying the hereditary factors affecting intelligence is the investigation of the development of twins. We have sufficient information to know the probability of differences between fraternal and identical twins. Thus, for example, if we study twins reared apart under different environmental conditions, we may be able to make some definite conclusions regarding the effect of the different environments. In the same way significant data may also be obtained from the studies of foster children, that is, children from the same family placed in different homes.

One of the first twin studies in this country was made by Thorndike in 1905. He found on the examination of 50 pairs of twins that the coefficient of correlation of their capacities was between .6 and .9, and of siblings about .3. Older twins were no more alike than younger ones, and therefore it may be concluded that the environmental factor was not as significant as the hereditary factor. Later studies showed that the resemblance between identical twins and fraternal twins showed no great differences. The question naturally arises as to whether the inheritance of intelligence in children of a family differed from one child to another. When identical twins are removed from a family, however, the resemblance continues to a greater extent than when fraternal twins are moved into different environments.⁸ In studies in which a large number of twins were tested on standard tests and followed for some time, the reports showed that fraternal twins resemble each other in about the same degree as siblings but that identical twins show a much greater resemblance. This was illustrated in a study by Tallman.⁹ She examined 158 pairs of twins and 200 siblings. Of the twins, 63 pairs were identical. She found that of the siblings, one to four years apart, the average I.Q. difference was 12

⁸ See E. L. Thorndike, *The measurement of twins, Archives of Philosophy, Psychology and Scientific Method*, 1905, 1, 1-64; C. Merriman, *The intellectual resemblances of twins, Psychological Monographs*, 1924, 33.

⁹ G. G. Tallman, *A comparative study of identical and non-identical twins with respect to intelligence resemblances, 1928, 27th Yearbook, National Society for the Study of Education*, pp. 83-86.

points, the identical twins 5 points, the nonidentical twins 7 points. Tallman concluded that the twins were about twice as similar in intelligence as the siblings. Similar results were obtained on the differences between identical and nonidentical twins in achievement tests and in school performance. A number of reports have shown that the coefficient of correlation on achievement tests as well as on intelligence tests is about .7 for fraternal twins reared together and .9 for identical twins reared together.

Other studies on twins have shown variable but not contrasting results. Hirsch,¹⁰ for example, pointed out that although heredity and environment are both naturally effective in determining the intellectual development of a child, heredity nevertheless is about five times as important as the environment in determining the intelligence quotient.

An interesting phase of the comparison of monozygotic and dizygotic twins is the relative differences between the anthropometric measures and intelligence tests results. For example, whereas the differences between the I.Q.'s of monozygotic and dizygotic twins are usually very great, the anthropometric indices do not differ greatly. Stocks'¹¹ results showed that differences are sometimes as great as 50 to 75 per cent, and sometimes 100 per cent in the comparison between dizygotic and monozygotic with interrelations between monozygotic.

It is extremely difficult to make specific conclusions regarding the genetic factors involved in the development of intelligence and in the maintenance or change of I.Q. One of the difficulties arises from the problem of testing. As an example, twins who had been separated from each other and who have been retested have been shown at times to be very different. In some of these cases one of the pair of twins had lived in an urban, complex environment which afforded many facilities for cultural and educational learning. The other twin lived in a rural or relatively isolated environment in which the facilities were scarce, the educational opportunities few, and the tempo of the

¹⁰ N. D. Hirsch, Twins: heredity and environment, 1930, Cambridge, Harvard University Press.

¹¹ P. Stocks, A biometric investigation of twins and their brothers and sisters, *Annals of Eugenics*, 1930, 4, 49-108.

environment slow. Comparison of the I.Q.'s of two such individuals does not give sufficient evidence regarding their similarities or differences. The test score is basically related to the achievement level of an individual, necessarily dependent upon capacity, but nevertheless also dependent upon information which he obtains from his environment. If tests existed which did not deal with information as the direct result of education and cultural influences, we might be more sure of our testing procedures. In a number of investigations, however, the environmental influences of separated twins have been taken into account, and the results have shown that when the environmental factors are controlled the hereditary nature of intelligence has been amply illustrated.

Chapter 15

INTELLECTUAL SUPERIORITY

A summary of the pertinent facts about intellectual superiority (genius) is presented in this chapter in order to compare the attributes of the intellectually superior child with those of the intellectually inferior. The material is presented not to illustrate intellectual aberration as expressed in superiority, but rather to illustrate the behavior differences between superior and inferior children.

The term genius has been used in a variety of meanings. The popular concept of genius is that of a mentally brilliant person who accomplishes some extraordinary feat, usually along a productive direction. Thus, a chemist who develops a new and important compound is popularly conceived as being a genius. The term genius has also been popularly applied to individuals who show some outstanding ability. From the psychological viewpoint productivity is not an index of genius. The term refers to intellectual ability rather than to productivity or peculiarity. If the term genius is accepted as meaning an extraordinarily high mental ability, the question arises regarding the level at which an individual can be called a genius. That level is obviously an arbitrary one, and the term may be applied to a variable number of people, depending upon the standard which psychologists use. In general, most psychologists agree that not more than 1 per cent and usually less than 1 per cent should be classified as genius on the basis of their ability to perform on standard intelligence tests. Formerly, a child with an I.Q. of 140 or more was classified as an intellectual genius, but in recent years there has been reconsideration of the level at which the term genius should be applied. As a result of this reconsideration, a majority of psychologists believed that the term should be applied only to individuals whose I.Q.'s are above 160 and

preferably above 180. The change in the psychologists' attitudes regarding the level of intelligence which justifies a diagnosis of genius did not arise from the problem of predicting the degree of productivity of individuals of various I.Q. levels. Although it may be assumed that an individual with an I.Q. of 180 will be more productive than an individual with an I.Q. of 150, the actual level of intelligence cannot be used as the only criterion for a prognosis regarding productivity. It is well known that many children whose I.Q.'s are approximately 140 become much more productive as adults than many whose I.Q.'s are 160 or higher. The interests, the motivations, and the productivity of an individual depend on personality factors rather than upon intelligence, although a given level of intelligence is necessary for independent productivity.¹

Predictions regarding the productivity of an individual with a high I.Q. are difficult to make, especially because no systematic study has been reported in which a significant number of children classified as geniuses have been studied through their adult years. Much of our knowledge about the relationship between intelligence and productivity during adult years has been obtained from retrospective interpretations of the probable intelligence of persons who have been known as geniuses. Such a study was made by Terman and his associates.² Three hundred and one men who were classified as geniuses, were selected for an historical study of their probable intelligence. After gathering the data on their development and productivity a group of judges estimated their probable intelligence quotients. Thus, John Stuart Mill was rated as having an I.Q. of 190 on the basis of such judgments, and Faraday, the scientist, was rated on one group of judgments to have an I.Q. of 110. Abraham Lincoln was judged to have had an I.Q. of 125; John Adams, 120; Ben Jonson, the English dramatist, 120; and James Madison, 120. It is evident that the estimates were made not

¹ J. G. Rockwell, Intelligence testing; its basic assumptions and unanswered questions, *Educational Method*, 1939, 19, 80-82; P. Witty, Some considerations in the education of gifted children, *Educational Administration and Supervision*, 1940, 26, 512-521.

² L. M. Terman, Editor, *The early mental traits of three hundred geniuses*, *Genetic Studies of Genius*, II, 1926, Stanford University, Stanford University Press.

on the basis of the final accomplishments of these men of eminence, but rather on the data which can be obtained regarding their early development, and especially on the data regarding their early intellectual characteristics. It is true, of course, that final accomplishments may be a poor criterion of the intellectual status of an individual, since so many factors can either interfere with or facilitate productivity. Nevertheless, historical data regarding early attributes can also lead to a great deal of error.

Much of the material upon which we may judge the intelligence of an individual may not be available in the historical annals of a person's life. The biographical material may also be distorted, and thus erroneous impressions may be obtained regarding the intellectual growth of an individual. We know also that a very brilliant child may, because of various personality disturbances, be unable to show his intelligence overtly. We have evidence from current observations that many children of high intelligence perform poorly scholastically, and apparently show very little intellectual curiosity. Many of these children are psychoneurotic and their energies and interests are absorbed in their emotional involvement in themselves. Hence, they are unable to perform well in school and their interests seem to be shallow. On the other hand, an average or slightly superior child who is well adjusted and has had stimulating training may appear to be far more intelligent than his actual native intelligence. This is especially true of children who are verbally fluent and are able to impress others with their supposed brilliance.

It is naturally far easier to trace the heredity of children or adults who are classified as geniuses than the ancestry of average or defective individuals. Studies which were first made by Galton, as well as contemporary investigations, have shown that the hereditary influences are important in the determination of genius. The question naturally arises as to whether factors other than heredity may also be important in the production of mentally superior persons. It is well known, for example, that the occupational status of the parents of mentally superior children is at a much higher level than that of the parents of

average children. It is therefore possible that the better environmental influences and educational facilities which these parents can afford may be factors in the development of mental superiority. Terman's studies have shown, however, that the average incomes of the families of mentally superior children were not significantly higher than the incomes of families of normal children, nor were the educational facilities significantly better for children who were classified as geniuses. There is no doubt, however, that the influence of the parents is of far more importance for mentally superior children than for average or defective children. On the basis of all the evidence, it seems that although the environment of the superior children is better, the hereditary influence is probably the most important factor. This does not mean, however, that there is direct inheritance of genius. The laws of heredity in cases of genius are essentially the same as in cases of mentally defective children. In both types there are carriers in the ancestry which by fortunate or unfortunate combinations and patterning result either in mental superiority or in mental deficiency.

Developmental Processes

According to Terman, mentally superior children are physically superior to average children. They excel the average children in height and weight and in general muscular development. The health histories of these children also show a more normal development than in the cases of average children and physical defects are found less frequently amongst them. The differences in the frequency of physical defects between children classified as genius and those classified as mentally deficient is quite marked.

The attainments of the mentally superior children are superior to those of average or defective children from the very first time that they are able to exhibit their abilities. Gesell³ found that the majority of persons of superior mental ability were precocious during their childhood. Most of the psychological

³ A. Gesell, *Infancy and human growth*, 1928, New York, The Macmillan Co.

and biological processes begin to mature in these individuals at a much earlier age and the rate of development is also faster than in average persons. He concluded that intellectual superiority has a definite biological basis, and as a result is likely to assert itself in a productive way in adult years unless unusual conditions prevail or personality abnormalities develop. The majority of gifted children learn to read before they enter school. They learn to talk three to four months earlier than average children, and their physical activity and coordination are also superior. According to recent studies, children of superior intelligence are recognized very early because of their quick understanding, their intellectual curiosity, their early speech, their large vocabularies, and their excellent memories. Their superiority is usually recognized because of their unusual ability in abstract intelligence, especially in their understanding of mathematics. Their early intellectual superiority is corroborated by their superiority in school. In general, the academic development of mentally superior children shows very few inequalities in their levels of achievement on different subjects. The majority of intellectually superior children are promoted to grades which children much older than they usually attend. Nevertheless, they still continue to do superior work in whatever grade they are found. Terman, at Stanford University, found that 85 per cent of intellectually superior children were accelerated in their school placements. When these children were examined for their academic achievement it was found that they were significantly superior to average children in all subjects requiring abstract thinking, and were also superior in subjects such as penmanship, manual training, and even in sports. Their greatest superiority was in reading. The intellectually superior children surpassed the average children both in reading interests and in reading ability. In spite of their great superiority, the mentally superior children were not one-sided or uneven in their achievements or in their academic motivation. Although an occasional instance is found of a superior child who does average or inferior school work, the largest majority distinguish themselves very early. As a result many school officials have had a great deal of difficulty with these gifted children because of the discrepancy be-

tween their physical and social development and their intellectual attainments.

In general, the play interests of mentally superior children are similar to those of normal children during early childhood. When adolescence is reached, differences appear. Gifted children at that time become intensely interested in reading and in intellectual pursuits, whereas average adolescents continue their interests in play activities and in haphazard pursuits.

One of the problems which has interested psychiatrists is the relationship between intellectual superiority and personality development. Contradictory evidence has been obtained by different investigators regarding this problem. Terman has emphasized the fact that the mentally superior child shows exceedingly few deviations. According to Terman, intellectual superiority is paralleled by superiority of character and personality. Although he did not make an exhaustive psychiatric study of the emotional and personality characteristics of these children, a number of pertinent observations were made, and various personality tests were administered. From the results of these observations and tests, Terman concluded that the mentally superior child is more likely to develop a normal personality than the average or defective child, perhaps by the very virtue of his superior intelligence. According to such an interpretation, it may be implied that the gifted child has a better understanding of the problems which he faces and hence is able to adjust to them much more normally than the average or dull child who is likely to be confused by his difficulties and frustrations. Furthermore, because of the insight of the gifted child, direct and indirect therapy by persons in his environment is much more effective than similar therapy in the cases of average or defective children. Contrary evidence regarding the personalities of gifted children has been reported by others, notably Paul Witty. These investigators have pointed out the high incidence of personality aberrations in gifted children and the frequent problems they present to teachers and parents. A mentally superior child is likely to meet more problems, and is more sensitive to the discrepancies between his attitudes and his attainments. Extensive statistical studies, except for those of

Terman, have not been made, however. Terman's conclusions are generally accepted, although there is no doubt that mental superiority may cause personality maladjustments in many instances. It is evident, however, that the mentally superior child who has personality or other defects will be more quickly singled out for study than will the average child with similar problems. This is obviously due to the disappointment of teachers and parents regarding the lack of attainment of the mentally superior child, whereas they expect but little from the defective or average child and hence are not as greatly disturbed by his difficulties. If Terman's findings regarding the personalities of superior children are correct, it should also follow that the frequency of neuroses among superior persons is less than among average or defective individuals. No systematic report of such a study is available in the literature, but occasional studies have been made upon the relationship between intelligence and neurotic traits. These reports are not definitive from the statistical standpoint, however. They do indicate that the nature of the neurotic symptoms may be related to the level of intelligence. For example, phobias and certain types of paranoid ideas are much more frequent in individuals of lower intelligence than in individuals of superior intelligence. Obsessive neuroses and ideas of grandeur are as frequent and have been occasionally reported as more frequent in persons of higher mentality than in persons of average or defective mentality. Differences in the nature of the symptomatology might be expected, however, principally because an individual's problems differ according to his intelligence. Such differences give, however, no clues regarding the ease with which neurotic symptoms develop in mentally superior children or data regarding the therapeutic prognosis in the cases of mentally superior individuals.

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GLOSSARY

Achondroplasia. Defects of the cartilage at the epiphyses of the long bones.

Acrocephaly. A head of high vertical index.

Adventitia. The outer layer of arteries.

Agenesis. Defective development or absence.

Alkalosis. Excessive alkalinity of body fluids.

Amaurotic Degeneration. Degeneration resulting in blindness.

Ammon's Horn. A portion of the cerebral cortex having a characteristic coiled form and unusual structure, which lies along the medial portion of the temporal lobe and bounds the inferior horn of the lateral ventricle.

Ankle Clonus. Alternate rigidity and relaxation of the foot after sudden stimulation.

Anoxemia. Deficient oxygen content of the blood.

Astrocyte. A star-shaped cell of the neuroglia.

Athetosis. A derangement of muscular control manifested by constantly recurring slow movements of the hands and feet, resulting from some brain injury.

Aura. A sensation of some type (visual, gastric, etc.) occurring before an epileptic attack.

Autism. Relating to experiences in which there is some retreat or dissociation from reality.

Babinski Reflex. Extension of the toes instead of flexion as the result of stimulating the sole of the foot. The positive Babinski is indicative of some pyramidal tract lesion.

Barbiturate Derivative. A derivative of barbital used as a hypnotic.

Basal Ganglia. The ganglia below the cortex connecting the cerebrum with the lower centers.

Basophilic. Staining with basic dyes such as certain cells of the blood.

Blastomatous. Relating to a true tumor or localized growth.

Blastophoric. Relating to the spermatoblasts which are not converted into spermatozoa.

Bradyphrenia. A condition of fatigability of interest and psychomotor activity.

Cataleptic. A state marked by muscular rigidity and suspension of voluntary motion.

Cephalocele. A hernial protrusion of part of the cranial contents.

Cholesterol. A fat-like substance (a monatomical alcohol) found in animal fats and especially abundant in the nervous tissue.

Choroid Plexus. A vascular fold of the pia occurring in the third, fourth, and lateral ventricles.

Chromatin. The more stainable portion of the cell nucleus.

Chromatolysis. The disintegration of the chromatin of the cell nucleus.

Cicatrization. The healing process which leaves a scar.

Climacterium. The physiological changes occurring especially at puberty and menopause.

Corpus Callosum. The arched mass of white matter connecting the cerebral hemispheres.

Demyelinization. Destruction or removal of the myelin of nerve tissue.

Dentate Nucleus. A large nucleus embedded within the hemisphere of the cerebellum from which the fibers of the brachium conjunctivum arise.

Diffuse Sclerosis. A form of sclerosis affecting large areas of the brain and cord.

Dioptr. The refractive power of a lens with a focal distance of one meter; assumed as a unit of measurement of refractive power.

Diplegia. Paralysis affecting like parts on either side of the body; bilateral paralysis.

Dizygotic. Pertaining to or proceeding from two zygotes.

Dyscrasia. Abnormal composition of the blood.

Dyskinesia. Impairment of the power of voluntary movement.

Dystrophy. Defective or faulty nutrition.

Echolalia. The meaningless repetition by a patient of words addressed to him.

Echopraxia. The meaningless and purposeless repetition of motions which have been started by the examiner. Also automatic imitation of motions made by others.

Ectoderm. The epiblast or outer layer of the primitive (two-layered) embryo; from it develop the epidermis and the neural tube.

Encephalogram. A roentgenographic plate made of the head following the removal of the cerebrospinal fluid and its replacement by air.

Encephalomacia. Morbid softness, or softening, of the brain.

Eosinophilia. The formation and accumulation of an unusual number of eosinophil cells in the blood.

Ependyma. The lining membrane of the ventricles of the brain and of the central canal of the spinal cord.

Epicanthus. A fold of the skin which sometimes covers the inner canthus.

Extrapolation. Prediction beyond the range of the data.

Falx Cerebri. The dural fold which separates the cerebral hemispheres.

Fontanelles. Any one of the unossified spots on the cranium of a young infant.

Glia. The supporting structure of nervous tissue.

Glial Proliferation. The reproduction or multiplication of neuroglia.

Glioma. A tumor composed of tissue which represents neuroglia in any one of its stages of development.

Globus Pallidus. The pale interior of the lenticular nucleus.

Grand Mal. An epileptic seizure in which there are convulsions and loss of consciousness.

Hemiatrophy. Atrophy or diminution in the size of one side of the body or of one-half of an organ or part.

Hemiplegia. Paralysis of one side of the body.

Hippocampus. A curved structure on the floor of the middle horn of the lateral ventricle. It is a submerged gyrus forming the larger part of the olfactory cerebral cortex.

Hyaloplasm. The more fluid, finely granular substance of the cytoplasm of cells.

Hyperextensal. Extreme or excessive extension.

Hypoglycemia. A deficiency of sugar in the blood.

Hypophyseal. Pertaining to the pituitary body.

Hypoplasia. Defective or incomplete formation.

Infundibulum. A funnel-shaped extension of the third ventricle extending through the hypothalamus to the end in the pituitary body.

Interstitial. Pertaining to or situated in the interstices or interspaces of a tissue.

Jacksonian Epilepsy. A form of epilepsy which is marked by localized spasm, and is mainly limited to one side and often to one group of muscles; also called partial.

Ketogenic. The ketogenic substances in metabolism are the fatty acids and certain of the amino-acids of protein.

Leptomeningitis. Inflammation of the pia and arachnoid of the brain or spinal cord.

Little's Disease. A general term for many forms of cerebral spastic diplegia.

Macrophages. Metchnikoff's name for a large mononuclear wandering phagocytic cell which originates in the tissues.

Meningocele. Hernial protrusion of the meninges.

Mesencephalon. The midbrain; the smallest of the six subdivisions of the brain.

Mesodermal. Relating to the middle of the three layers of the primitive embryo.

Monozygotic. Pertaining to or derived from one zygote.

Myxedema. A disease due to hypofunction of the thyroid gland, and marked by dropsey-like swelling, especially of the face and hands, smallness of the thyroid gland, slowing of the pulse rate, dryness and wrinkling of the skin, etc.

Narcolepsy. A condition marked by an uncontrollable desire for sleep occurring at intervals.

Neopallium. The nonolfactory portion of the cerebral cortex; so called because it is of later development than the archipallium.

Neuroglia. The supporting structure of nervous tissue.

Neuropathic. Pertaining to or characterized by a nervous disorder.

Nevoid Amentia. Amentia with a nevoid condition of the trigeminal region (face or scalp), signs of damage to the pyramidal system, and fits.

Nissl Bodies. Large granular protein bodies which stain with basic dyes, forming the substance of the reticulum of the cytoplasm of a nerve cell.

Nystagmus. An involuntary rapid movement of the eyeball, which may be either lateral, vertical, rotary, or mixed, i.e., composed of two varieties.

Ogive. An S-shaped curved; a term used in biometry.

Oligodendroglia. Tissue composed of nonneural cells of ectodermal origin forming part of the adventitial structure of the central nervous system.

Olivary Body. Oval prominences at the sides of the anterior pyramids of the oblongata.

Oxycephaly. A condition in which the top of the head is pointed with a vertical index above 77.

Papilledema. Edema of the optic papilla; choked disk; optic neuritis due to intracranial pressure and without inflammatory manifestations.

Parenchymatous. The essential or functional elements of an organ as distinguished from its stroma, or framework.

Paroxysmal. Recurring in paroxysms.

Perivascular. Situated around a vessel.

Petit Mal. The mild form (of epilepsy) in which vertiginous or other sensations take the place of convulsions.

Polyblast. Maximow's name for a large mononuclear phagocytic cell with a deeply staining nucleus of irregular form originating from wandering cells of tissues.

Polydactylism. The occurrence of more than the usual number of fingers or toes.

Porencephalus. The presence of cysts or cavities in the brain cortex communicating with the arachnoid spaces and penetrating deeply into the brain, due to arrest of development or to congenital disease that produces atrophy of the brain matter.

Prodromal. Premonitory; indicating the approach of a disease.

Psychogalvanic Reflex. Decreased electric resistance of the body as a result of emotional agitation.

Purkinje Cells. Large branching neurons in the middle layer of the cortex cerebelli.

Putamen. The outer and darker part of the lentiform (lenticular) nucleus.

Pyknolepsy. Recurring epileptiform attacks in children, resembling petit mal, but not of an epileptic nature.

Scaphocephaly. Having a keeled or boat-shaped head.

Sesamoid Bone. A small flat bone developed in a tendon which moves over a bony surface.

Spasmophilic Diathesis. A condition in which the motor nerves show abnormal sensitiveness to mechanical or electric stimulation, and the patient shows a tendency to spasm, tetany, and convulsions.

Spina Bifida. Congenital cleft of the vertebral column with meningeal protrusion.

Strabismus. A squint deviation of one of the eyes from its proper direction, so that the visual axes cannot both be directed simultaneously at the same objective point.

Substantia Nigra. An area of gray matter dorsal to the basis pedunculi.

Subtentorial. Beneath the tentorium.

Sulcus. A groove, trench, or furrow, especially a fissure of the brain.

Sylvian Aqueduct. A canal about three-fourths of an inch long extending downward from the mesencephalon from the third to the fourth ventricle.

Syndactylism. The condition in which two or more fingers or toes are more or less completely grown together or adherent; webbed fingers or toes.

Syndrome. A complex of symptoms; a set of symptoms which occur together; the sum of signs of any morbid state.

Synostosis. The union of adjacent bones by means of osseous matter, such as ossification of their connecting cartilage.

Tegmentum (of the pons). The grayish upper covering of the pedunculus (crus) cerebri; the upper and larger of the two principal parts of either crus cerebri.

Tentorium. An anatomical part resembling a tent or a covering.

Tetany. A syndrome manifested by sharp flexion of the wrist and ankle joints (carpopedal spasm), muscle twitchings, cramps, and convulsions, sometimes with attacks of stridor.

Tetrad Differences. A mathematical condition of the correlations to justify the use of a single common factor.

Trichinosis. A disease condition due to infestation with trichinae.

Tuberous Sclerosis. A condition characterized pathologically by the presence of numerous glial tumors within the brain, and marked by progressive mental deterioration, epileptic convulsions, and tumors of the skin and viscera.

Vacuolization (of cytoplasm). Any space or cavity formed in the protoplasm of a cell.

Virchow-Robin Spaces. A lymph space between the outer and middle coats of an artery.

Zygomatic Arches. The arches formed by the zygomatic process of the temporal bone and by the malar bone.

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